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SELECTED WATER RESOURCES ABSTRACTS

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A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management ond Budget through September 30, 1985.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey, MS 421
Reston, VA 22092

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03 WATER SUPPLY AUGMENTATION AND CONSERVATION

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04 WATER QUANTITY MANAGEMENT AND CONTROL

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05 WATER QUALITY MANAGEMENT AND PROTECTION

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08 ENGINEERING WORKS

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

STATISTICAL ESTIMATION OF POLYNOMIAL GENERALIZED COVARIANCE FUNCTIONS AND HYDROLOGIC APPLICATIONS,
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
P. K. Kitanidis.
Water Resources Research, Vol. 19, No. 4, p 909-921, August, 1983. 3 Fig, 32 Ref. NSF grant CME-8106577.

Descriptors: *Statistical methods, *Hydrology, *Covariance, Variance, Rainfall, Error analysis, Model studies, Network design.

Three methods for the estimation of the parameters of the polynomial generalized covariance function (a useful model for nonstationary functions) are presented and evaluated: maximum likelihood (ML), minimum variance unbiased quadratic (MVUQ), and minimum norm (least squares). The estimation error covariance matrix of the parameters is calculated with each of these methods. ML and MVUQ estimation have very good properties and, for reasonably large samples, give very similar results. Minimum norm estimation is appropriate for preliminary data analysis. The application of these methodologies is illustrated with a set of rainfall data. The estimation of the parameters of the covariance function involves sizeable errors. In practice, it may be rather difficult to identify the parameters of all but simple models. The proposed parameter estimation methods can be very useful in evaluating and accounting for the effect of parameter uncertainty in the design of hydrologic data collection networks. (Moore-IVI)
W84-01884

MATHEMATICAL SIMULATION OF INTERDEPENDENT SURFACE AND SUBSURFACE HYDROLOGIC PROCESSES,
Science and Education Administration, Fort Collins, CO. Agricultural Research.
R. E. Smith, and R. H. B. Hebbert.
Water Resources Research, Vol. 19, No. 4, p 987-1001, August, 1983. 21 Fig, 23 Ref.

Descriptors: *Storm seepage, *Slopes, *Infiltration, Permeability coefficient, Hillslopes, Mathematical models, Simulation, Hydrodynamics, Soil water, Perched water, Unsaturated flow, Rainfall-runoff relationships, Western Australia.

A mathematical model is introduced which represents an attempt to integrate all of the major hydrologic response mechanisms presently identified as contributing to the hydrology of a simple hillslope, by selecting efficient approximations for key elements in hillslope hydrodynamics: infiltration and movement in the unsaturated flow zone. The hillslope is considered to consist of two soil layers with the lower soil capable of restricting vertical flow at the interface to create a perched aquifer and subsurface stormflow. The slope of the interface is arbitrary. A kinematic method for routing unsaturated vertical flow is linked consistently with a modern analytically derived infiltration model, which operates when rainfall exceeds surface saturated hydraulic conductivity Ks. The model is used to demonstrate several of the relationships between rainfall flux, soil hydraulic properties, hillslope geometry, and runoff characteristics. The model is also applied to simulate experimental data from a hillslope in Western Australia. Vertical movement in the perched water table along the hillslope and primarily in the near-stream region is potentially more significant in most hillslopes than horizontal flux of the resulting perched aquifer. Subsurface stormflow recession characteristics are probably much more related to the loss pattern into the subsoil of spatial variability of permeability in the surface soil zone than to a characteristic response function of the aquifer hydraulics. The dynamics of the saturated excess response and the subsurface stormflow are both heavily influenced by conditions such as gradients, water table heights, soil depth, and saturations. Subsoil response delay time is largely controlled by the depth of the unsaturated zone. Multiple peaks may be produced from a relatively uncomplicated hyetograph when the expansion of the saturated excess zone interacts with the changes in the rainfall rate. (Moore-IVI)
W84-01892

CALIBRATION OF SNYDER COEFFICIENTS FOR PENNSYLVANIA,
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
A. C. Miller, S. N. Kerr, and D. J. Spaeder.
Water Resources Bulletin, Vol. 19, No. 4, p 625-630, August, 1983. 3 Fig, 2 Tab, 14 Ref.

Descriptors: *Surface runoff, *Unit hydrographs, *Pennsylvania, Rainfall-runoff relationships, Regression analysis, Storm runoff, Maps.

Unit hydrograph theory is one of the most widely used techniques to predict surface runoff. The present study is concerned with the Snyder unit hydrograph and the calibration of the Snyder coefficients for Pennsylvania. Twenty-seven study basins were selected, located randomly across the state. With the rainfall and runoff recorded for several events for each basin (more than 500 events were analyzed) unit hydrographs were calculated and the Snyder coefficients determined. A map of the coefficients was drawn to illustrate the variability in the coefficients and two equations using multiple regression theory were developed. The unexplained variability of the coefficients suggests that upper and lower bounds on the peak flow might be placed on storm hydrographs developed for ungaged watersheds. (Author's abstract)
W84-01949

ALTERATION OF OCEANIC CRUST AND GEOLOGIC CYCLING OF CHLORINE AND WATER,
Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.
E. Ito, D. M. Harris, and A. T. Anderson, Jr.
Geochimica et Cosmochimica Acta, Vol. 47, No. 9, p 1613-1624, September, 1983. 3 Fig, 5 Tab, 116 Ref.

Descriptors: *Water cycle, *Geohydrology, *Chlorides, *Geochemistry, Subduction, Hydrothermal studies, Volcanoes, Water transport, Solute transport, Plate tectonics, Geologic cycling, Oceanic crust, Magma, Ocean bottom.

New estimates of transport rates for H2O and Cl between the mantle and surface reservoirs are reported. The estimates take into consideration alteration of oceanic crust, especially that of plutonic rocks, and possible subduction of sediments. The effect of (hydrothermal) alteration on the Cl budget seems to be negligible, but the effect on the H2O budget is significant. Altered oceanic crust (excluding sediments) contains about 10 times as much H2O as the unaltered crust, and its subduction may result in a net transport of H2O to the upper mantle in subduction zones. However, the rate of expulsion of H2O from the mantle by subduction-zone magmatism is comparable to the amount released by ridge magmatism, and is only about 10% of the amount subducted. Therefore, about 90% of the subducted H2O must be returned to the mantle or returned to the crust by other processes. In addition, subduction of oceanic sediments to mantle depths will result in a further increase in the return rate of H2O to the mantle reservoir, and possible net transfer of Cl to the mantle, depending on the rate of pore water expulsion. The reflux of subducted H2O to the surface reservoirs is not fully accounted for by igneous activity at volcanic arcs in subduction zones, or mantle H2O associated with igneous acitvity at oceanic spreading centers and hotspots. (Moore-IVI)
W84-01986

THROUGHFALL AND STEMFLOW IN THE FOREST NUTRIENT CYCLE,
G. G. Parker.
Advances in Ecological Research, Vol. 13, 1983. 14 Fig, 5 Tab, 280 Ref.

Descriptors: *Cycling nutrients, *Precipitation, *Throughfall, *Stemflow, *Forests, Minerals, Forest soils, Leaching, Dry deposition, Washoff.

The quality of precipitation falling on forests is altered during a brief but significant interaction with the surfaces of plants, resulting in the transfer of additional mineral matter to the forest floor. While incident precipitation is the largest nutrient input to many forests, throughfall fluxes are substantially greater, ranging from 1.27 (for NO3-N) to 11.2 times as high (for K). These alterations in nutrient concentrations involve numerous processes and combine materials originating both within (biotic) and outside of the forest ecosystem (atmospheric). The resulting flux is a pathway of rapid mineral cycling, a route for transferring metabolic biproducts and substances of allelochemic and pedogenic importance and a method for washing the air filtering surfaces of the forest canopy. Throughfall and stemflow are major pathways in nutrient recycling. The annual nutrient return to the forest soil for the elements K, Na and S is predominantly via throughfall and stemflow and little due to litterfall. Stemflow transfers only 5-20% of the total in precipitation-borne solutes, yet it is the major nutrient input to restricted areas of the forest floor. Incident precipitation is an underestimate of input and net forest water is an overestimate of canopy-mediated recycling. Without estimates of dry deposition and subsequent washoff, nutrient cycles are unbalanced and atmospheric losses poorly quantified. Throughfall and stemflow show much variability in concentration and deposition, far more than for incident precipitation. Sampling and analyses of forest waters present special chemical and statistical problems. For nutrient budgets, a major difficulty lies in obtaining an accurate and independent estimate of the forest hydrologic budget. For the majority of elements, leaching is the major contribution in net throughfall. (Moore-IVI)
W84-01987

MODEL STUDY OF THE SHORT-TERM CLIMATIC AND HYDROLOGIC EFFECTS OF SUDDEN SNOW-COVER REMOVAL,
National Oceanic and Atmospheric Administration, Princeton, NJ. Geophysical Fluid Dynamics Lab.
T.-C. Yeh, R. T. Wetherald, and S. Manabe.
Monthly Weather Review, Vol. 111, No. 5, p 1013-1024, May, 1983. 16 Fig, 13 Ref.

Descriptors: *Snow cover, *Soil water, *Climate, Albedo, Mathematical models, Simulation, Evaporation, Soil temperature, Air temperature, Insolation, Atmospheric circulation.

This paper describes the results from a set of numerical experiments which simulate the effect of a large scale removal of snow cover in middle and high latitudes during the early spring season. This is done through use of a simplified general circulation model with a limited computational domain and idealized geography. It is found that removal of snow cover reduces the water available to the soil through snowmelt and decreases soil moisture in this region during the following seasons. Furthermore, it also reduces surface albedo in this region and increases adsorption of insolation by the ground surface. This, in turn, heats the ground surface and allows more evaporation to occur. However, the change of evaporation is relatively small owing to the low values of surface temperature in high latitudes. Therefore, the negative anomaly of soil moisture induced initially by the removal of snow cover persists for the entire spring and summer seasons. The removal of snow cover also affects the thermal and dynamical structure of the atmosphere. It is found that the increase of surface temperature extends into the upper troposphere thereby reducing both meridional temperature gradient and zonal wind in high latitudes. (Author's abstract)
W84-02042

2B. Precipitation

A MILLIMETER-WAVELENGTH DUAL-POLARIZATION DOPPLER RADAR FOR CLOUD AND PRECIPITATION STUDIES,
National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
F. Pasqualucci, B. W. Bartram, R. A. Kropfle, and W. R. Moninger.
Journal of Climate and Applied Meteorology, Vol. 22, No. 5, p 758-765, May, 1983. 7 Fig, 1 Tab, 17 Ref.

Descriptors: *Precipitation, *Radar, Climate Storms, Clouds, Meteorological data collection, Micrometeorology, Montana.

A pulse Doppler radar system operating at 35 GHz and having full polarization (linear and circular) diversity capability is described. Separate antennas are used for the transmitter and the receiver because this design approach allows better overall radar sensitivity. The transmitter operates in the double-pulse mode to optimize the unambiguous Doppler velocity measurable with the system. A polarizer capable of handling about 200 kW of peak power when pressurized with sulfur hexafluoride at 25 psi was developed for the transmitter. The radar system has built-in test sequences for checking the gain and alignment of the transmitter and receiver antennas. The dual-polarization intermediate frequency receiver has a total of six analog channels. A very flexible data acquisition and processing system has been developed to allow both coherent and incoherent dual-polarization measurements to be performed; the system includes a microprocessor-controlled pulse-pair processor and a minicomputer with associated peripherals. The radar was operated successfully in Montana during the 1981 Cooperative Convective Precipitation Experiment. Preliminary results on the observed variation of the circular depolarization ratio demonstrate the usefulness of this sytem for monitoring the kinematics and microphysics of clouds and precipitation with good space and time resolution. (Baker-IVI)
W84-01854

SURVEY OF RADAR RAIN MEASUREMENT TECHNIQUES,
National Severe Storms Lab., Norman, OK.
R. J. Doviak.
Journal of Climate and Applied Meteorology, Vol. 22, No. 5, p 832-849, May, 1983. 10 Fig, 74 Ref.

Descriptors: *Rainfall, *Measuring instruments, Rain gage, Clouds, Storms, Estimating.

Several methods used to estimate rainfall rate R are surveyed. The distribution N(D) of drop sizes is of central importance in determining the reflectivity factor Z, attenuation rate K, and R. With single-parameter measurement techniques either of the remotely sensed parameters Z or K can be used to estimate R when gross assumptions on N(D) can be made. If N(D) can be described by a two-parameter distribution, dual measurement techniques can better estimate R without involving these coarse assumptions. A review is made of three techniques whereby two variables might be measured: 1) dual wavelength in which Z and K are remotely measured, 2) dual polarization in which reflectivity is measured with two orthogonal polarizations, and 3) raingage-radar combinations whereby in situ point measurements of R and radar measurement of Z or R are combined to obtain a better assessment of rain over areas between gages. It was concluded that there is still no satisfactory proven method in use to estimate rain rate or liquid water content accurately when high spatial and temporal resolution is needed. Dual-parameter measurement techniques appear to offer the best solution for rain rate estimation if N(D) is a significant error source and high resolution is reqired. There is need to evaluate the relative importance of error sources other than uncertainty in N(D). (Baker-IVI)
W84-01855

SPECIFICATION OF MONTHLY PRECIPITATION IN THE WESTERN UNITED STATES FROM MONTHLY MEAN CIRCULATION,
California Univ., Davis. Dept. of Land, Air and Water Resources.
B. C. Weare, and M. A. Hoeschele.
Journal of Climate and Applied Meteorology, Vol. 22, No. 6, p 1000-1007, June, 1983. 8 Fig, 2 Tab, 16 Ref.

Descriptors: *Rainfall, *Weather forecasting, Spatial distribution, Forecasting, California, Oregon, Washington.

The ability to specify monthly precipitation at 36 stations in Washington, Oregon and California by various indices of monthly mean circulation has been investigated. Most of the circulation indices were derived from eigenvector analyses of 700 mb geopotential heights or relative vorticity for 1951-76 or 300 mb relative vorticity for 1963-76. The results indicate that an average up to 60% of the rainfall variance may be specified by same-month average circulation parameters. The 700 mb parameters analyzed within a limited domain in the vicinity of the rainfall network result in the best specification ability. Indices derived from larger domains or from the 300 mb vorticities result in generally poorer specifications. Considerable spatial variation in specification ability is apparent with greatest skills evident in the coastal region of northern California and Oregon and lowest skills in the eastern regions of all three states. (Author's abstract)
W84-01856

HEAVY THUNDERSTORMS OBSERVED OVER LAND BY THE NIMBUS 7 SCANNING MULTICHANNEL MICROWAVE RADIOMETER,
Wisconsin Univ.-Madison. Space Science and Engineering Center.
R. W. Spencer, W. S. Olson, W. Rongzhang, D. W. Martin, and J. A. Weinman.
Journal of Climate and Applied Meteorology, Vol. 22, No. 6, p 1041-1046, June, 1983. 9 Fig, 23 Ref.

Descriptors: *Thunderstorms, *Satellite technology, *Weather forecasting, Rain, Radiometry, Clouds, Climate, Temperature effects.

In an examination of microwave data from the Nimbus 7 satellite, brightness temperatures were found that were much lower than those expected for the radiation emanating from rain-producing clouds. Even over land brightness temperatures much colder than those predicted from rain layer models occasionally are observed and in every case of cold brightness temperature heavy rain was observed at the surface. The cold temperatures can be explained if there is a thick layer of precipitation-sized ice hydrometeors above the rain. The same structure, presumably a wide, strong updraft, that allows a storm to carry precipitation well above the freezing level apparently also favors heavy rain. Thus it appears that the 37 GHz observations do at times contain information on relatively heavy rain rates. The coincidence of the coldest brightness temperatures with the most extreme weather events suggests as well that the 37 GHz channel may have some value in detecting severe local storms. (Baker-IVI)
W84-01857

PRECIPITATION IN SOUTHERN NEVADA,
Nevada Univ. System, Las Vegas. Water Resources Center.
R. H. French.
Journal of Hydraulic Engineering, Vol. 109, No. 7, July, 1983. 6 Fig, 8 Tab, 8 Ref. DOE contract DE-AC08-DPO-1253.

Descriptors: *Precipitation, *Nevada, Spatial distribution, Temporal distribution, Groundwater recharge, Flash floods.

The distribution of precipitation in both time and space in the southern Nevada area is examined. It is concluded that this area can be divided into two zones of precipitation separated by a transition zone on the basis of annual average precipitation. One region, relative to the other area, is defined to be a deficit annual average precipitation region. This observation could have a significant impact on groundwater recharge estimates and on the siting of facilities which must be protected from flash floods. In addition precipitation records at two stations in the southern Nevada area were examined and point intensity/duration relationships were derived for these stations. (Author's abstract)
W84-01965

LARGE FALLS OF RAIN IN WALES - A SIMPLE STATISTICAL CASE STUDY,
I. T. Jolliffe.
Weather, Vol. 38, No. 4, p 103-106, April, 1983. 3 Tab, 1 Ref.

Descriptors: *Rainfall, *Statistical analysis, *Frequency, Storms, Wales, Beacons Reservoir, Swansea.

The possibility that an apparent increase in the frequency of large rainfalls from the period 1926-1980 as compared to the period prior to 1925 in Wales may be due strictly to chance is investigated. Three well known probability distributions (binomial, Poisson, exponential) are used to determine the validity of this theory. The three techniques come to somewhat similar conclusions. For Beacons Reservoir there is strong evidence that the frequency of falls of rain of at least 2 or 3 in. is higher for the later parts of the data. The evidence is less convincing for higher rainfalls (4 and 5 in.) but this may be partly due to the small amounts of data which are available. For Swansea, there is no convincing evidence that the frequency of large rainfalls has changed during the period of observation. (Baker-IVI)
W84-01988

CIRCULATION TYPE AND THE SPATIAL DISTRIBUTION OF PRECIPITATION OVER CENTRAL, EASTERN AND SOUTHERN ENGLAND: PART II,
J. Stone.
Weather, Vol. 38, No. 7, p 200-205, July, 1983. 8 Fig, 17 Ref.

Descriptors: *Weather patterns, *Precipitation, *Atmospheric circulation, Spatial distribution, England, Rainfall distribution.

A study was made of maps showing the mean daily precipitation for the period 1961 to 1975 with the various cyclonic directional (or hybrid) types in the Lamb catalogue. Indications were clear that the spatial variation of the mean daily precipitation varied a great deal with different circulation types. Proximity to low pressure, the curvature of the isobars and frontal activity are all important factors which help to explain these variations. Other factors include the uplift afforded by relatively low hills, sometimes no more than 50 meters high, and relative exposure to or shelter from moist winds from the sea. Uplift and exposure are especially important when they operate in combination. This can be seen in sourthern counties with both the straight isobar and cyclonic southerly and southwesterly types. On these occasions significantly more precipitation fell inland over the low hills away from the coastal lowlands. This form of intensification of precipitation also occurs in Norfolk when moist air streams blow inland off the North Sea. At the same time, however, many southern and south-western areas are sheltered and receive less precipitation than Norfolk. Anticyclonic types generally give light intensities. Certain areas received high daily precipitation from relatively few circulation types. East Anglia for example, received large falls mainly from the cyclonic, cyclonic north-westerly, straight isobar northerly and cyclonic northerly types. (Baker-IVI)
W84-01989

RAINSHADOW - THE DYNAMICAL FACTOR,
Queen Mary Coll., London (England).
B. W. Atkinson.

Weather, Vol. 38, No. 9, p 264-269, September, 1983. 4 Fig, 9 Ref.

Descriptors: *Rainfall distribution, *Weather patterns, *Rainshadow, Precipitation, England, Wales.

Distribution of precipitation over a given area in a unit time is largely a function of the interplay between airflow, cloud physics and topography. If the effects of uniform frontal uplift and orography are combined, one would expect a large precipitation area associated with the front within which heavier precipitation would occur over hills. Conversely, when presented with a precipitation map showing strong localization of precipitation over upland areas, it would be easy to conclude, though perhaps wrongly, that only orographical influences had been operating. In considering such a case it becomes clear that precipitation which occurred on 29 July 1967 over England and Wales resulted from a combination of dynamical, orographical and cloud-physical factors. As the frontal rain areas moved north-eastward, a striking rainshadow effect appeared. This lack of precipitation to the lee of the Welsh hills was due largely to the dynamical factor rather than the orographical and cloud-physical factors. The case is an interesting reminder that rainshadows are not always what they seem to be. (Baker-IVI)
W84-01990

DIAGNOSTIC STUDIES OF RAINFALL ANOMALIES IN NORTHEAST BRAZIL,
Wisconsin Univ.-Madison. Dept. of Meteorology.
P.-S. Chu.
Monthly Weather Review, Vol. 111, No. 8, p 1655-1664, August, 1983. 12 Fig, 18 Ref.

Descriptors: *Rainfall, *Brazil, *Atmospheric circulation, Drought, Departure patterns, Rainy season, Dry season, Weather, Sea surface temperature.

The large-scale atmospheric circulation of the Brazil-Atlantic sector is studied in relation to extreme rainfall anomalies in two large regions of Northeast Brazil (Nordeste). Long-term rainfall series, aerological records of stations in South America, and ship observations over the tropical Atlantic form the data base for this study. Departure patterns of meteorological elements over the Atlantic are investigated for composites of extremely dry and wet years in the southern and northern Nordeste. Southern Nordeste's peak rainy season is around November/December. The wet years in the southern Nordeste are marked by negative pressure departures over the South Atlantic, weak onshore southeast trades and anomalously cold waters along the south Brazil coast. These features appear to be related to Southern Hemispheric frontal systems. During the dry years, departure patterns are nearly reversed to those of the wet years. Northern Nordeste receives its maximum rainfall in March/April. Rainfall variations are modulated by the latitudinal displacement of the baric trough and confluence axis over the equatorial Atlantic and concomitant sea surface temperature anomalies. Case studies of recent extreme years indicate the possible existence of a local meridional circulation. The more northerly position of the convergence band over the Atlantic, the anomalously cold waters to the south of the equator and the subsidence in the southern portion of the thermally-induced meridional circulation cell over the Nordeste, characteristics of drought years, are all unfavorable for rainfall in Northeast Brazil. (Author's abstract)
W84-02040

SUB-SAHARAN RAINFALL IN THE YEARS 1976-80: EVIDENCE OF CONTINUED DROUGHT,
Clark Univ., Worcester, MA. Graduate School of Geography.
S. E. Nicholson.
Monthly Weather Review, Vol. 111, No. 8, p 1646-1654, August, 1983. 7 Fig, 1 Tab, 20 Ref. NSF grant ATM-80-19009.

Descriptors: *Drought, *Rainfall, *Sub-saharan Africa, Africa, Biogeophysical feedback.

Rainfall is represented by a standarized annual departure calculated as the ratio of the annual departure to the standard departure. The departures for each of the five years are calculated for four semi-arid sub-Saharan zones (Sahelo-Sahara, Sahel, Soudan, Soudano-Guinean) and compared with values for the period 1901-75. Departures for regional subdivisions and individual stations are also derived. The analysis clearly shows that drought persisted in the region until at least 1980. Rainfall was well below normal in all four zones in 1976 and 1977. In most areas, deficits for these years were comparable to those of 1972 and 1973, the years of most extreme drought. Rainfall was below average in all years in nearly every region and for nearly every station. The persistence of extreme rainfall deficits throughout the 1970's may be a result of a biogeophysical feedback mechanism which promotes intense and persistent droughts. (Moore-IVI)
W84-02041

LINEAR ORGANIZATION OF LOCALIZED STORMS IN THE SUMMER RAINFALL ZONE OF SOUTH AFRICA,
Hebrew Univ., Jerusalem (Israel). Inst. of Earth Sciences.
D. Sharon.
Monthly Weather Review, Vol. 111, No. 3, p 529-538, March, 1983. 10 Fig, 4 Tab, 13 Ref.

Descriptors: *Rainstorms, *South Africa, Spatial distribution, Rainfall distribution, Drought, Seasonal variation.

The spatial organization of localized showers in the summer rainfall region of South Africa has been studied by means of spatial correlation functions. A predominant linear arrangement of parallel shower belts has been identified, with an orientation between W-E and WNW-ESE. No differences were found in this respect between the driest years in the 1960's and the wettest ones in the 1950's and 1970's, but a linear trend was absent, or at least not prevalent at any fixed orientation, during the dry spell extending from the late 1940's to the early 1950's. The above linear trend has been found to persist also throughout the year, though, in general, rainfall appeared as spatially less organized during summer months than during spring and autumn. (Author's abstract)
W84-02043

RELATIONSHIP BETWEEN EASTERN EQUATORIAL PACIFIC SEA SURFACE TEMPERATURES AND RAINFALL OVER INDIA AND SRI LANKA,
National Weather Service, Washington, DC. Climate Analysis Center.
E. M. Rasmusson, and T. H. Carpenter.
Monthly Weather Review, Vol. 111, No. 3, p 517-528, March, 1983. 9 Fig, 6 Tab, 28 Ref.

Descriptors: *Rainfall, *Sea surface temperature, *India, *Sri Lanka, El Nino, Monsoons, Forecasting.

Monsoon season (June-September) precipitation data from 31 Indian subdivisions and mean monthly precipitation data from 35 Indian and Sri Lanka stations, spanning the period 1875-79, were analyzed to determine the relationship between equatorial Pacific warm episodes (El Nino events) and interannual fluctuations in precipitations over India and Sri Lanka. The data reveal a strong tendency for a below normal summer monsoon during the 25 moderate/strong warm episodes which occurred during the period. For example, area-averaged June-September rainfall over India was below the median value in 21 of the 25 warm episode years. These years include the five largest, and nine of the eleven largest, negative monsoon season anomalies. Considerably smaller average departures occurred during the monsoon seasons of the year preceding and the year following the warm episode, and during the remaining months of the warm episode year. The anomaly pattern over Sri Lanka and extreme southern India is quite different, the major feature being a period of above normal precipitation during the autumn of the warm episode year. During a typical warm episode, positive sea surface temperature anomalies appear along the Ecuador Peru coast early in the year, and thus precede the summer monsoon by several months. The forecasting implications of this relationship are discussed. (Author's abstract)
W84-02044

ONSET OF THE AUSTRALIAN MONSOON DURING WINTER MONEX: SYNOPTIC ASPECTS,
Australian Numerical Meteorology Research Centre, Melbourne.
N. E. Davidson, J. L. McBride, and B. J. McAvaney.
Monthly Weather Review, Vol. 111, No. 3, p 496-516, March, 1983. 10 Fig, 1 Tab, 23 Ref.

Descriptors: *Monsoons, *Australia, *Weather, Troposphere, Clouds, Satellite technology, Southern Hemisphere.

A case study is presented of the onset of the Southern Hemisphere summer monsoon at longitudes near Australia during December 1978. The numerical analyses comprising this case study are used in conjunction with station data and operational manually derived analyses for other years to investigate the following: 1) the ease of definition of monsoon onset; 2) the three-dimensional structure of the troposphere during an active monsoon situation; and 3) the flow changes preceding and during the transition from a period of suppressed to a period of enhanced cumulonimbus activity over tropical Australia. A well-defined onset occurs in six of the seven years considered. Onset, defined as a satellite-observed, large-scale increase in tropical convection, is consistent with that determined by the wind criterion of Troup (Indian J. Meteor. Geophys., 1961, 12, 217-230). In 1978 onset occurs in two stages: an increase in convergence, followed by an increase in convection. The monsoon cloudiness exists entirely in the region of low-level westerly wind. The convergence extends through a deep layer from the surface at 400 mb and exists in the upward branch of two linked Hadley cells, one from each of the Northern and Southern Hemispheres. Observations of the flow changes prior to onset lead to the hypothesis that the trigger mechanism lies in the Southern Hemisphere subtropics. It is conjectured that the seasonal buildup of planetary-scale land-sea temperature gradients has reached a critical stage such that the troposhere is in a state of readiness for the monsoon. Before the onset can take place, however, it must wait for the Southern Hemisphere midlatitude synoptic systems to be in such a configuration that low-level trade wind easterlies are prevalent across the Australian continent. The evidence is discussed also in favor of various alternative triggering mechanisms such as the influence of a Northern Hemisphere cold surge in the South China Sea and the westward propagation of equatorial westerlies from the Pacific Ocean near the international date line. (Author's abstract)
W84-02045

PHYSICAL BASIS FOR CHANGES IN THE PHASES OF THE SUMMER MONSOON OVER INDIA,
World Meteorological Organization, Baghdad (Iraq). Regional Training Center.
P. S. Pant.
Monthly Weather Review, Vol. 111, No. 3, p 487-495, March, 1983. 5 Fig, 1 Tab, 20 Ref.

Descriptors: *Monsoons, *Rainfall, *India, Weather, Meridional circulation, Mathematical models, Tibetan plateau, Eddy heat flux.

The summer monsoon over India is described as 'active' when large parts of India, particularly the central parts and the west coast receive normal or above normal rainfall. It is described as having a 'break' when the rainfall is below normal over most parts of India, except in the hills in the north and in the southeastern parts of the country. It is shown in this paper that when a break sets in, there is an in-situ formation of a zonally oriented trough at 10-15 degrees N at 700 mb over south India and

the adjoining seas. Simultaneously, there is a sharp fall in the 500 mb temperature over the Tibetan Plateau to much below normal values. As the plateau warms and attains near normal temperature, the trough in the south shifts northward and occupies the normal active monsoon trough position (around 20 degrees N) over north India. Considering the importance of meridional circulations in the tropics, it is reasonable to expect that the changes in the 700 mb flow with the phase changes are associated with corresponding changes in the meridional circulation. Computations of vertical motion along 75 degrees E with the help of quasi-geostrophic model show that under break monsoon conditions, the Hadley cell with its upward limb in the trough at 10-15 degrees N over south India and descent further north, predominates. Whereas, in the active monsoon phase, the monsoon cell, with a rising limb at about 20 degrees N and descent in the south, is prominent. The physical process through which the sudden cooling over the Tibetan Plateau brings about a change in the meridional circulation, and therefore a change in the phase of the monsoon from an active to a break situation, is explored through a quasi-geostrophic streamfunction for the meridional circulation. It is seen that eddy fluxes, particularly of heat, are one to two orders of magnitude larger at the northern end of the monsoon cell at the time of disruption of the monsoon. The vertical motions induced by these eddy fluxes are seen to be in the right direction to bring about a switch over from the monsoon cell to the Hadley cell. The re-establishment of the monsoon cell and with it the active phase appears to take place slowly through radiational heating over the Tibetan Plateau. (Author's abstract)
W84-02046

2C. Snow, Ice, and Frost

MELTWATER MOVEMENT IN A DEEP SNOWPACK; 1. FIELD OBSERVATIONS,
British Columbia Univ., Vancouver. Dept. of Geography.
P. Jordan.
Water Resources Research, Vol. 19, No. 4, p 971-978, August, 1983. 8 Fig, 22 Ref.

Descriptors: *Snowmelt, *Snowpack, *Flow, Unsaturated flow, Darcy's law, Conductivity, Capillary pressure, Hydrologic budget, Energy, Wave front, Hydraulic properites, Water content.

The flow of meltwater through a snowpack can be described by Darcy's law, and by a set of equations relating conductivity, capillary pressure, and liquid water content which are similar to the equations governing unsaturated groundwater flow. Field observations were conducted which were designed to test the applicability of the unsaturated flow equations to the description of meltwater movement at the scale of a small watershed. Simple instrumentation was used to measure capillary pressure and meltwater flux rates; this was supplemented with energy and water balance measurements for the study watershed. Observations of surface snowmelt, meltwater flux, and streamflow for the snowmelt period confirm the nature of meltwater flow as described by the unsaturated flow equations, and illustrate the controlling influence of snowpack hydraulics on the streamflow hydrograph. Observed speeds of the meltwater wave front in the snowpack average about 0.22 m/h, and capillary pressures and kinematic wave speeds observed are comparable to those reported in other deep-snow environments. The difficulty of obtaining reliable liquid water content measurements is identified as a major limitation in the determination of hydraulic properties of the snowpack. (Author's abstract)
W84-01890

MELTWATER MOVEMENT IN A DEEP SNOWPACK; 2. SIMULATION MODEL,
British Columbia Univ., Vancouver. Dept. of Geography.
P. Jordan.
Water Resources Research, Vol. 19, No. 4, p 979-985, August, 1983. 3 Fig, 1 Tab, 8 Ref.

Descriptors: *Snowmelt, *Snowpack, *Flow, Unsaturated flow, Mathematical models, Simulation, Energy, Hydraulic properties, Permeability coefficient, Conductivity, Capillary pressure, Water content.

A numerical simulation model is developed describing the one-dimensional flow of meltwater in a snowpack, based on established methods of modeling unsaturated groundwater flow. The results of field observations of snowmelt and meltwater flow are used to determine parameters describing the hydraulic properties of the snowpack, and surface energy balance measurements are used as input to the model. Tests of the performance of the model show a high sensitivity to the saturated hydraulic conductivity of the snowpack and to liquid water content of the snow. Saturated hydraulic conductivity can be measured with acceptable precision by simple field methods; however, measurement of liquid water content is more difficult and constitutes the major limitation affecting calibration of the model. The model is relatively insensitive to exponents in the power law equations relating conductivity, capillary pressure, and liquid water content. Meltwater wave speeds predicted by the model are somewhat slower than those observed in the field. Observations of snowpack layering and horizontal inhomogeneity of flow suggest that these features affect transient storage of meltwater and consequently cause meltwater wave speeds to differ from those predicted by a one-dimensional model. (Author's abstract)
W84-01891

HYDROMETEOROLOGICAL SIGNIFICANCE OF RIME ICE DEPOSITS IN THE COLORADO ROCKIES,
Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
E. E. Hindman, R. D. Borys, and P. J. DeMott.
Water Resources Bulletin, Vol. 19, No. 4, p 619-624, August, 1983. 3 Fig, 1 Tab, 24 Ref. NSF grant ATM 8109590.

Descriptors: *Rime ice, *Snowpack, *Mountains, Water content, Clouds, Snow, Rocky Mountains, Steamboat Springs, Colorado.

Observations and measurements were made during storm periods at mountain top sites in the Colorado Rockies during the winter of 1981-1982. On average, liquid clouds occurred with and without snowfall for, respectively, 75% and 15% of the observations. On average, the rime ice deposition rates were measured to be seven times the precipitation rates. The rime deposits were estimated to contribute 10% to the water content of the snowpack. Combining this figure with the estimated rime deposits on falling snow crystals (up to 50% by mass), up to 60% of the water content of the annual snowpack in the mountains near Steamboat Springs, Colorado, could be due to rime ice deposits. (Author's abstract)
W84-01948

2D. Evaporation and Transpiration

FREE AND FORCED CONVECTION EFFECT ON EVAPORATION,
Clemson Univ., SC. Dept. of Mathematics.
B. L. Sill.
Journal of Hydraulic Engineering, Vol. 109, No. 9, p 1216-1231, September, 1983. 7 Fig, 3 Tab, 18 Ref.

Descriptors: *Evaporation, *Surface water, Mathematical studies, Convection, Wind, Temperature effects, Mathematical equations.

The effects of free and forced convection mechanisms on evaporation from open water bodies is examined. Analogies between momentum, heat, and mass transfer from flat surfaces are employed to develop expressions for free and forced convective mass transport (evaporation). Use of these expressions with existing data sets from seven water bodies allows evaluation of the efficiencies of the two convection mechanisms. For the range of conditions studied here, forced convective transfer occurs at its theoretically predicted rate (or 100% efficient). However, the presence of a wind tends to disrupt free convective transport with the result that this mechanism becomes ineffective at high wind speeds or low values of surface to air temperature difference. A new form of the Dalton type evaporation equation is also presented which is applicable over a wide range of conditions. (Baker-IVI)
W84-01967

2E. Streamflow and Runoff

TRANSVERSE MIXING IN WIDE AND SHALLOW RIVER: CASE STUDY,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Civil and Environmental Engineering.
A. C. Demetracopoulos, and H. G. Stefan.
Journal of Environmental Engineering, Vol. 109, No. 3, p 685-699, June, 1983. 6 Fig, 5 Tab, 22 Ref.

Descriptors: *Mixing, *River flow, Mathematical models, Thermal pollution, Cooling water, Effluents, Nuclear powerplants, Tracers, Transverse mixing, Mississippi River.

A method has been proposed for the computation of the transverse mixing coefficient in wide and shallow rivers. The effluent from a side channel heated discharge was used as a tracer in this study. A modified method of moments was developed for the computation of transverse mixing coefficients. Modifications were introduced to account for: tracer loss by a first order process; and for variability of stream cross sections. The method is general and permits use of effluent site data without additional instream experimentation. An application of the technique to the Monticello Nuclear Power Generating Plant cooling water outfall on the upper Mississippi River yielded an average dimensionless transverse mixing coefficient with a range from 0.24-4.65. This average is similar to that reported for other streams, and about one order of magnitude larger than the values derived from laboratory experiments. (Moore-IVI)
W84-01773

FLOW IN ALLUVIAL-RIVER CURVES,
Universidad Central de Venezuela, Caracas. Facultad de Ingenieria.
M. F. Ascanio, and J. F. Kennedy.
Journal of Fluid Mechanics, Vol. 133, p 1-16, August, 1983. 8 Fig, 15 Ref.

Descriptors: *Fluid mechanics, *Channels, *Alluvial rivers, Rivers, Shear stress, Fluctuations.

Uniform flow in curved, wide, erodible-bed channels is formulated on the basis of the conservation of flux of moment-of-momentum, to obtain relations for the vertical distributions of radial-plane velocity and radial shear stress. The expression for the radial stress exerted on the bed is utilized in a force-equilibrium analysis of the moving bed layer to obtain relations for the average transverse slope of the bed and for the radial bed profile. The reduction of primary bed shear stress due to the net radial transport of streamwise momentum toward the outer (concave) bank is then calculated, by introducing the derived expressions for the velocity components into the momentum equation for the primary-flow direction. It is found that the stress reductions in deep, narrow channels can exceed 50%. Bed profiles and velocity distributions measured in natural and laboratory streams are found to be in good conformity with those calculated from this moment-bases theory. (Author's abstract)
W84-01851

CALCULATION OF SORPTIVITY FROM CONSTANT-RATE RAINFALL INFILTRATION MEASUREMENT,
Southern Illinois Univ. at Carbondale. Dept. of Forestry.
For primary bibliographic entry see Field 2G.
W84-01863

MELTWATER MOVEMENT IN A DEEP SNOWPACK; 1. FIELD OBSERVATIONS,
British Columbia Univ., Vancouver. Dept. of Geography.
For primary bibliographic entry see Field 2C.
W84-01890

MELTWATER MOVEMENT IN A DEEP SNOWPACK; 2. SIMULATION MODEL,
British Columbia Univ., Vancouver. Dept. of Geography.
For primary bibliographic entry see Field 2C.
W84-01891

RELIABILITY OF THE DESIGN STORM CONCEPT IN EVALUATING RUNOFF PEAK FLOW,
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
P. Beaudoin, J. Rousselle, and G. Marchi.
Water Resources Bulletin, Vol. 19, No. 3, p 483-487, June, 1983. 4 Fig, 10 Ref. Quebec Ministry of Education grant CRP-356-75, IBM of Canada grant CR-3065-80.

Descriptors: *Flood peak, *Runoff rate, *Computer models, Design storms, Rainfall-runoff relationships, Soil water, Rainfall intensity, Rainfall duration, Rainfall frequency, Montreal, Quebec.

A comparative study was undertaken to evaluate peak runoff flow rates using (1) a continuous series of actual rainfall events and (2) design storms. The ILLUDAS computer model was used to simulate runoff over a catchment within the city of Montreal, Canada. A ten-year period, five-minute increment rainfall data base was used to derive peak flow frequency curves. Two types of design storms were analyzed: one derived from intensity duration frequency curves (Chicago type), the other from averaging actual rainfall patterns (Huff type). Antecedent soil moisture conditions were considered in the analyses. It was found that the probability distribution of runoff peak flow was sensitive to the choice of design storm pattern and to the antecedent soil moisture condition. A symmetrical, Chicago-type design storm with antecedent dry soil moisture produced a flow frequency curve similar to the one obtained from a series of historical rainfall events. (Author's abstract)
W84-01935

NONLINEAR RUNOFF MODELING: PARAMETER IDENTIFICATION,
California Univ., Davis. Dept. of Civil Engineering.
G. G. Patry, and M. A. Marino.
Journal of Hydraulic Engineering, Vol. 109, No. 6, p 865-880, June, 1983. 10 Fig, 5 Tab, 25 Ref. CSRS project CA-D*-LAW-4254-H.

Descriptors: *Rainfall-runoff relationships, *Mathematical models, Urban watersheds, Simulation, Hydrographs, Quebec, Montreal, Curotte-Papineau.

A nonlinear functional rainfall-runoff model is applied to an urban watershed (Curotte-Papineau, Montreal) and the results are compared with those from the ILLUDAS model. Simulations are performed using a 5 minute time interval in order to better define the characteristics of the hydrographs. Particular emphasis is placed on the identification of the most appropriate set of model parameters, namely the memory of the catchment (U) and the order of expansion of the first-order and second-order kernels M1 and M2. Parameter identification based on calibration results alone can lead to unpredictable verification (prediction) results; while calibration results improve with increasing values of M1 and M2, verification results do not exhibit the same consistency. Consequently, a two-way calibration-verification analysis is recommended for obtaining the best set of model parameters. Further, results of the nonlinear functional runoff model compare favorably with those of the ILLUDAS model. (Author's abstract)
W84-01961

REALISTIC ASSESSMENT OF MAXIMUM FLOOD POTENTIALS,
D. W. Newton.
Journal of Hydraulic Engingeering, Vol. 109, No. 6, p 905-918, June, 1983. 6 Fig, 13 Ref.

Descriptors: *Probable maximum flood, *Probability, *Dam design, Dam evaluation, Design floods, Rainfall distribution, Storms, Headwaters, Flood hydrographs, Climate, Tennessee Valley.

A procedure is proposed which uses probability concepts to achieve a consistent realistic assessment of the probable maximum flood (PMF) and its use in design or evaluation of high-hazard dams. A PMF computation involves selection of a sequence of meteorologic and hydrologic events. These include the principal storm, antecedent and/or subsequent storms, time and areal distribution of rainfall, loss rates, and the hydrograph determination. Computed maximum headwater levels used in dam design or evaluation depend on assumed initial reservoir levels, operating conditions, and windwave conditions. A review of present practice shows basic agreement on events or conditions to postulate, but signficant differences in their magnitude. These differences produce major variations in the relative magnitude of computed flood. Further, some events are defined in terms which, when applied in different climatic regions, will result in computed floods of varying relative magnitude. The results of studies conducted by Tennessee Valley Authority to establish a consistent and realistic standard for PMF determination in the Tennessee Valley region are used to illustrate the proposed procedures. (Author's abstract)
W84-01962

FLOW DEPTH IN SAND-BED CHANNELS,
Tetra Tech, Inc., Pasadena, CA.
For primary bibliographic entry see Field 8B.
W84-01963

MAIN FLOW VELOCITY IN SHORT RIVER BENDS,
Technische Hogeschool, Delft (Netherlands). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W84-01964

FLOOD PLAIN AND MAIN CHANNEL FLOW INTERACTION,
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W84-01966

A RESIDUAL NOISE MODEL FOR STREAMFLOW PREDICTION,
Ontario Ministry of the Environment, Toronto. Water Resources Branch.
L. A. Logan, W. C. Lennox, and T. E. Unny.
Canadian Journal of Civil Engineering, Vol. 10, No. 3, p 437-449, 1983. 7 Fig, 1 Tab, 15 Ref.

Descriptors: *Streamflow, *Prediction, Forecasting, Model studies, Residual noise, Hydrologic models.

A nonlinear, conceptual hydrologic model is formulated for use in predicting flows under conditions of controlled input. The model has time invariant parameters and a residual noise model is incorporated for sequential prediction of hourly flows using a closed loop feedback scheme with hypothetically controlled inputs which are adapted to the residuals. The residual model derived comprises error terms which are correlated in time and variable. This implication was resolved from the fact that more effective improvement in prediction was attained in cases where the hydrologic model residual autocorrelations appear to be correlated. The suitability of the model to predict flows at different times at a site involving data not included as part of the calibration and with suboptimal basic model parameters is demonstrated. This residual noise and adapted input control adjustment approach will be useful in simple test applications for contingency plans on control of reservoir releases during storm events, or as a means of providing a measure for flood mitigation at damage centers. (Baker-IVI)
W84-01983

DYNAMIC MODEL FOR THE OVERLAND FLOW ON AN INFILTRATING CATCHMENT,
Helsinki Univ. of Technology, Espoo (Finland). Systems Theory Lab.
K. Pingoud.
Applied Mathematical Modelling, Vol. 7, No. 2, p 128-134, April, 1983. 7 Fig, 21 Ref.

Descriptors: *Surface runoff, *Overland flow, *Infiltration, Mathematical models, Rainfall-runoff relationships, Catchment areas, Simulation.

An approximate lumped parameter model for the surface runoff phenomenon on a catchment is presented. It consists of two submodels which are spatial discretizations of the basic partial differential equations of overland flow and infiltration. The aim of the model is to describe the dynamical input-output relationship between the rainfall rate and the surface runoff from the catchment. The boundary conditions of the infiltration process are modelled in an approximate way so that the number of state variables in the model can be reduced. With the aid of a single model parameter it is possible to describe simple catchment shapes like linearly converging and diverging surfaces. The model structure is flexible so that it can also be applied to more complex catchment configurations. The simulation results show that the phenomenon under consideration can be properly described by the model structure presented. (Moore-IVI)
W84-01994

FLOODS: AUSTRALIA'S AWFUL VISITATIONS,
Bureau of Meteorology, Melbourne (Australia).
J. F. Elliott.
Weatherwise, Vol. 36, No. 3, p 114-117, June, 1983. 2 Fig.

Descriptors: *Floods, *Australia, Flood control, Cyclones, Rainfall, Flood damage, Monsoons, Urban areas, Flood forecasting.

Floods are a major problem in Australia with almost every area of the continent subject to this type of devastation. Floods are particularly severe in their effects when they occur near major population centers and areas of intense agriculture which are often found on lower river valleys and plains. The inland rivers of northern New South Wales drain very productive agricultural areas and a number of provincial cities are sited on their flood plains. The area is subject to frequent flooding and despite various measures taken to mitigate their effects, floods continue to be a problem. Cyclonic and monsoonal rain are the major causes of flooding in the country. Flash floods are also a problem, but not as severe a problem as in the United States. Flood forecasting and warning services, coupled with a range of emergency service and counter disaster activities have been developed to varying degrees in most areas. Land use controls and planning measures are also being adopted. (Baker-IVI)
W84-01998

2F. Groundwater

DETERMINATION OF BULK ROCK PROPERTIES FROM GROUND-WATER LEVEL FLUCTUATIONS,
Texas A and M Univ., College Station. Dept. of Geology.
P. A. Domenico.
Bulletin of the Association of Engineering Geologists, Vol. 20, No. 3, p 283-287, 1983. 1 Tab, 16 Ref.

Descriptors: *Water level fluctuations, *Stress analysis, *Groundwater, Mathematical studies, Stress, Stress-strain curves, Stress analysis, Water level, Water table.

Ideas from stress-strain theory have been redeveloped in order to relate water level fluctuations to the bulk elastic properties of the last rock. The detailed constitutive relations for isothermal porous mediums are briefly restated. The response of ground-water levels to tides and changes in barometric pressure provides an in-situ measure of the response of the rock-water system to changes in stress. Tidal and barometric efficiencies can thus be expressed in terms of drained and undrained moduli. In addition, if the various moduli are known from laboratory measurements, the laboratory equivalents of both tidal and barometric efficiency can provide an estimate of the specific storage. The method is demonstrated to provide reasonable and consistent results when applied to various rock types of differing rigidity including clay, sandstones, limestone and basalt. (Baker-IVI)
W84-01813

IN-SITU DETERMINATION OF SOIL HYDRAULIC PROPERTIES DURING DRAINAGE,
Alabama Agricultural Experiment Station, Auburn.
J. H. Dane, and S. Hruska.
Soil Science Society of America Journal, Vol. 47, No. 4, p 619-623, July-August, 1983. 7 Fig, 19 Ref.

Descriptors: *Soil water, *Permeability coefficient, *Drainage, Boundary conditions, Soil water retention.

In-situ soil water retention and hydraulic conductivity relations were determined for two soils from knowledge of initial and boundary conditions and water content profiles during drainage. Empirical relations were assumed for each soil between volumetric water content (theta) and soil water pressure head (h), and between hydraulic conductivity (K) and theta. Assigning values to the parameters in these relations made it possible to solve the general water flow equation for the same initial and boundary conditions as encountered in the drainage experiments. Calculated water content profiles were compared with measured water content profiles at corresponding times. Differences in measured and calculated theta values provided information for changes to be made in the parameters. This procedure was repeated until a satisfactory agreement was found and the determined relations apparently represented the soils in question. (Author's abstract)
W84-01862

MATHEMATICAL MODEL FOR REGIONAL LAND SUBSIDENCE DUE TO PUMPING; 3. INTEGRATED EQUATIONS FOR A PHREATIC AQUIFER,
Delaware Univ., Newark. Dept. of Civil Engineering.
M. Y. Corapcioglu, and J. Bear.
Water Resources Research, Vol. 19, No. 4, p 895-908, August, 1983. 10 Fig. 16 Ref. Engineering Foundation grant RC-A-79-1A.

Descriptors: *Subsidence, *Pumping, *Drawdown, *Horizontal displacement, Aquifers, Mathematical models, Water table fluctuations, Groundwater surface, Confined aquifers, Stress.

A mathematical model is developed for the areal distribution of drawdown, land subsidence, and horizontal displacements due to groundwater pumping from a deformable phreatic aquifer. Following the development of a three-dimensional mathematical model consisting of a mass conservation equation, quasi-static equilibrium equations, and stress-strain relations for an assumed perfectly elastic solid matrix, a regional, horizontal two-dimensional model is derived by averaging the three-dimensional model over the vertical thickness of the aquifer, taking into account the continuous variation in total stress as a result of water table fluctuations. The separation of an initially coinciding phreatic surface, which serves as the upper boundary of the aquifer, and a surface consisting of a set of solid particles during the lowering of the water table and the compaction of the aquifer has been incorporated into the averaging procedure. The analytical solution for the case of a single pumping well, which is expressed in terms of the classical well function for a confined aquifer but with a modified storativity, provides estimates of drawdown, vertical subsidence, and horizontal displacements. The displacements for a sample problem are compared with those of a confined aquifer under similar conditions. Under the conditions of the studied case of radial flow, vertical and horizontal displacements due to pumping from a phreatic aquifer with the same discharge rate would be less than those of a confined one. The same averaging procedure is extended for a system of phreatic and leaky confined aquifers and for the unsaturated zone above the water table. An additional change in total stress is obtained in terms of moisture content of the zone above the phreatic surface. (Moore-IVI)
W84-01883

AQUIFER THERMAL ENERGY STORAGE: AN ATTEMPT TO COUNTER FREE THERMAL CONVECTION,
Auburn Univ., AL. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W84-01885

LABORATORY INVESTIGATIONS OF STEAM FLOW IN A POROUS MEDIUM,
W. N. Herkelrath, A. F. Moench, and C. F. O'Neil, II.
Water Resources Research, Vol. 19, No. 4, p 931-937, August, 1983. 6 Fig, 1 Tab, 17 Ref, 1 Append.

Descriptors: *Steam flow, *Geothermal studies, *Pressure, Sand, Silt, Clay, Porous media, Adsorption, Simulation, Mathematical models, Radioactive wastes.

Transient, superheated steam flow experiments were run by bringing a cylinder of porous material to a uniform initial pressure and then making a step increase in pressure at one end of the sample while monitoring the pressure transient breakthrough at the other end. At 100 degrees, 125 degrees, and 146 degrees C, the time required for steam pressure transients to propagate through an unconsolidated material containing sand, silt, and clay was 10-25 times longer than predicted by conventional superheated steam flow theory. The delay in the steam pressure transient may be caused by adsorption of steam in the porous sample. In order to account for steam adsorption, a sink term was included in the conservation of mass equation. Energy transfer in the system has to be considered because latent heat is released when steam adsorption occurs, increasing the sample temperature by as much as 10 degrees C. The steam pressure was a function of both the temperature and the amount of adsorption in the sample. This function was assumed to be an equilibrium adsorption isotherm, which was determined by experiment. By solving the modified mass and energy equations numerically, subject to the empirical adsorption isotherm relationship, excellent theoretical simulation of the experiments was achieved. Quantitative understanding of the physics of the flow of steam in porous media is important in modeling fluid transport in geothermal systems and in high-level nuclear waste repositories. (Moore-IVI)
W84-01886

THEORETICAL EXPLANATION OF SOLUTE DISPERSION IN SATURATED POROUS MEDIA AT THE DARCY SCALE,
Indiana Univ. at Bloomington. Dept. of Mathematics.
R. N. Bhattacharya, and V. K. Gupta.
Water Resources Research, Vol. 19, No. 4, p 938-944, August, 1983. 1 Fig, 18 Ref. NSF grants CME-8004498 and CME-8004499.

Descriptors: *Porous media, *Solute transport, *Dispersion, Peclet number, Convection, Probability, Darcy scale.

The transport of a nonreactive dilute solute in saturated porous media is explained at three distinct space-time scales. These are the kinetic, microscopic, and Darcy scales. The transition from one scale to the next higher scale, i.e., from the kinetic to the microscopic to the Darcy, is a consequence of the central limit theorem of probability theory. At the microscopic scale, the solid and the liquid phases together form a heterogeneous continuum. The microscopic solute concentration is governed by a parabolic equation with spatially varying drift and diffusion coefficients. The so-called dispersion phenomenon at the Darcy scale is shown to appear in the transition from the microscopic to the Darcy scale. In the computation of the dispersion coefficients, the Peclet number appears naturally as a dimensionless parameter. For large Peclet numbers the coefficients of dispersion at the Darcy scale are shown to be linear in the liquid convective velocity. A general expression is obtained which gives the order of magnitude of the dispersion coefficient for all Peclet numbers within the Darcy regime of the liquid convective velocities. This expression shows that for very small Peclet numbers, only the molecular diffusion provides the dominant contribution, whereas for intermediate values of Peclet numbers, both the liquid convection and the molecular diffusion contribute to the dispersion coefficients; in this range the dispersion coefficients are not linear in the liquid convective velocity. These findings are well supported by existing experimental observations. These theoretical insights into dispersion at the Darcy scale are also important in explaining the so-called macrodispersion and the scale effect at field scales. (Author's abstract)
W84-01887

STEADY STATE FLUID RESPONSE IN FRACTURED ROCK: A BOUNDARY ELEMENT SOLUTION FOR A COUPLED, DISCRETE FRACTURE CONTINUUM MODEL,
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Water Resources Engineering.
A. M. Shapiro, and J. Andersson.
Water Resources Research, Vol. 19, No. 4, p 959-969, August, 1983. 10 Fig, 19 Ref.

Descriptors: *Fractures, *Groundwater movement, *Aquifers, Mathematical models, Geohydrology, Porous media.

A discrete fracture representation of a highly fractured groundwater aquifer is inappropriate as a modeling approach since the location of all fractures can never be explicitly specified. However, the alternative of exclusively employing a continuum description of the medium then neglects any geologic information that exists with regard to the location of specific fractures in such formations. In order to take better advantage of geologic information in highly fractured aquifers a model is proposed which couples the discrete fracture and continuum conceptualizations. In regions where discrete fractures are designated, an efficient means of computing the steady state fluid responses is formulated with the use of the boundary element method. This allows the consideration of highly complex fracture geometries. since fluid responses in the porous rock are described with a set of linear equations written only in terms of the hydraulic head and fluid mass flux at the boundaries the porous rock shares with the fractures. One-dimensional equations of fluid movement in the fractures written in terms of the same variables make coupling of the two systems straight forward. In this technique, discretization only along the fractures is required. Thus the internal discretization of the host rock that would be characteristic in the use of finite difference and finite element methods is alleviated. At the boundary of the region where specific fractures are identified, a continuum conceptualization is coupled to the discrete fracture model. Steady state fluid responses in the continuum domain are defined using a semianalytic technique which is based on the discretization of Green's third identity. The resulting coupled model allows the discrete fracture and continuum conceptualizations to be employed in the modeling of those areas where they are judged to be most appropriate, based on the availability of physical information. (Author's abstract)
W84-01889

STABILITY ANALYSIS OF WATER MOVEMENT IN UNSATURATED POROUS MATERIALS 2. NUMERICAL STUDIES,
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
G. A. Diment, and K. K. Watson.
Water Resources Research, Vol. 19, No. 4, p 1002-1010, August, 1983. 9 Fig, 5 Tab, 17 Ref.

Descriptors: *Hydrodynamics, *Soil water, Stability analysis, Computer models, Mathematical models, Unsaturated flow, Infiltration, Porous media.

Hydrodynamic stability analysis is applied to the stability of several soil water systems some of which are potentially unstable. The first stage in the analysis requires the generation of water content and pressure head profiles using a computer-based numerical solution for the flow equation for unsaturated porous materials. These profiles permit the calculation of certain differential terms which appear in the specification of the coefficients required in the stability analysis. Results for growth rate of imposed disturbances of wavelengths of 1, 5, and 25 cm together with the appropriate eigenvectors are presented for infiltration into a homogeneous profile, redistribution following infiltration, infiltration into a scale hetergeneous medium, and infiltration into a fine-over-coarse stratified profile. Although instability was expected for the redistribution, heterogeneous, and layered systems, the results, while showing a noticeable trend toward instability, did not predict the occurrence of such a condition. All the analyses have been carried out with initial water contents of 0.05 cu cm/cu cm. Small amounts of initial water can have a significant effect on the damping-out of instabilities that otherwise would occur under dry initial conditions. (Moore-IVI)
W84-01893

FINITE ELEMENT TECHNIQUES FOR MODELING GROUNDWATER FLOW IN FRACTURED AQUIFERS,
GeoTrans, Inc., Reston, VA.
P. S. Huyakorn, B. H. Lester, and C. R. Faust.
Water Resources Research, Vol. 19, No. 4, p 1019-1035, August, 1983. 17 Fig, 5 Tab, 29 Ref. DOE contract E512-02900.

Descriptors: *Groundwater movement, *Geologic fractures, Mathematical models, Simulation, Porous media, Aquifers, Confined aquifers, Hydraulic gradients.

Four alternative conceptual models of groundwater flow in fractured aquifers are considered. The first three are based on the dual-porosity approach with different representations of fluid interactions between the fractures and porous matrix blocks, and the fourth is based on the discrete fracture approach. Two numerical solution techniques are presented for solving the governing equations associated with the dual-porosity flow models. In the first technique the Galerkin finite element method is used to approximate the equation of flow in the fracture domain and a convolution integral is used to describe the leakage flux between the fractures and porous matrix blocks. In the second the Galerkin finite element approximation is used in conjunction with a one-dimensional finite difference approximation to handle flow in the fractures and matrix blocks, respectively. Both numerical techniques are readily amendable to the governing equations of the discrete fracture flow model. To verify the proposed numerical tecniques and compare various conceptual models, four simulations of a problem involving flow to a well fully penetrating a fractured confined aquifer were performed. Each simulation corresponded to one of the four conceptual models. For the three simulated cases, where analytical solutions are available, the numerical and the analytical solutions were compared. Both solution techniques yielded good results with relative coarse spatial and temporal discretizations. Greater accuracy was achieved by the combined finite element-convolution integral technique for early time values at which steep hydraulic gradients occurring near the fracture-matrix interface could not be accommodated by the linear finite difference approximation. For cases involving transient simulation of leakage from the matrix blocks to fractures, greater accuracy was achieved by the combined finite element-convolution technique. The combined finite element-convolution technique should be used in preference to the combined finite element-finite difference technique if greater accuracy is required in the early time simulation. (Moore-IVI)
W84-01895

DEVELOPMENT OF REACTION MODELS FOR GROUND-WATER SYSTEMS,
Geological Survey, Reston, VA.
L. N. Plummer, D. L. Parkhurst, and D. C. Thorstenson.
Geochimica et Cosmochimica Acta, Vol. 47, No. 4, p 665-686, April, 1983. 3 Fig, 9 Tab, 46 Ref.

Descriptors: *Geochemistry, *Groundwater, *Reaction models, Thermodynamics, Mass balance, Simulation, Reaction paths, Dolomite, Carbon isotopes, Sulfur isotopes, Gypsum, Ferric hydroxide, Pyrite, Carbon dioxide, Organic carbon, Florida.

Methods are described for developing geochemical reaction models from the observed chemical compositions of ground water along a hydrologic flow path. The roles of thermodynamic speciation programs, mass balance calculations, and reaction-path simulations in developing and testing reaction models are contrasted. Electron transfer is included in the mass balance equations to properly account for redox reactions in ground water. The mass balance calculations determine net mass transfer models which must be checked against the thermodynamic calculations of speciation and reaction-path programs. Although reaction-path simulations of ground-water chemistry are thermodynamically valid, they must be checked against the net mass transfer defined by the mass balance calculations. An example is given testing multiple reaction hypotheses along a flow path in the Floridan aquifer where several reaction models are eliminated. Use of carbon and sulfur isotopic data with mass balance calculations indicates a net reaction of incongruent dissolution of dolomite (dolomite dissolution with calcite precipitation) driven irreversibly by gypsum dissolution, accompanied by minor sulfate reduction, ferric hydroxide dissolution, and pyrite precipitation in central Florida. Along the flow path, the aquifer appears to be open to CO2 initially, and open to organic carbon at more distant points down gradient. (Author's abstract)
W84-01984

SANDSTONE WATER SENSITIVITY: EXISTENCE OF A CRITICAL RATE OF SALINITY DECREASE FOR PARTICLE CAPTURE,
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
K. C. Khilar, H. S. Fogler, and J. S. Ahluwalia.
Chemical Engineering Science, Vol. 38, No. 5, p 789-800, 1983. 15 Fig, 3 Tab, 10 Ref. NSF grants NSF-G-ENG79-06647, NSF CPE 8108197.

Descriptors: *Sandstones, *Salinity, *Permeability, Clay, Water sensitivity, Groundwater movement, Particle capture, Clogging, Pores, Mathematical models, Berea sandstone.

A critical rate of salinity decrease (CRSD) was found to exist in the water sensitivity of Berea sandstone. The CRSD was determined by conducting core flood experiments in which the salinity was decreased exponentially by placing mixers of various volumes in the inlet stream. The CRSD is equal to a space velocity of 0.40/hr at a superficial velocity of 25.6 cm/hr. The superficial velocity has a significant effects on the CRSD. At a velocity of 2.4 cm/hr, the CRSD is equal to a space velocity of 0.10/hr. The CRSD decreases with decreasing velocity. Above the CRSD, drastic reductions in core permeability occur due to a log jam, or bridging effect, at the pore constriction. Below the CRSD, the released clay particles pass through the constriction without being captured and therefore very little reduction in core permeability occurs. A critical particle concentration was also identified above which bridging occurs. A mathematical model developed to delineate the regions of high and low permeability reductions was found to be in good agreement with experimental measurements. (Moore-IVI)
W84-01992

COMMON COMPOSITION CHARACTERISTICS OF FLUORIDE BEARING GROUNDWATERS,
Andhra Univ., Waltair (India). Dept. of Geophysics.
V. V. J. Sarma, and A. N. Swamy.
Water, Air and Soil Pollution, Vol. 20, No. 1, p 29-39, July 1983. 6 Fig, 1 Tab, 12 Ref.

Descriptors: *Groundwater, *Fluoride, Visakhapatnam basin, India, Calcium, Magnesium, Sodium, Sodium carbonate, Alkalinity.

During routine groundwater surveys of the Visakhapatnam basin, concentrations of fluoride ions above the permissible limit of 1 to 1.5 mg/l were detected near the village of Jaggayyapalem in Andhra Pradesh State, India. The fluoride bearing groundwaters of the area were compared with fluoride bearing groundwaters from different parts of the world. In general, there exists a good linear negative relationship between F(-) and Ca(2+) plus Mg(2+) ions, and a linear positive relationship between F(-) and HC03(-) ions in high fluoride bearing groundwater. Most of the fluoride bearing waters contain high to very high amounts of Na and are classified as high to very high alkali hazard waters. Almost all the waters contain very high amounts of residual sodium carbonate, exceeding the maximum value of 2.5 meq/l. (Moore-IVI)
W84-02124

2G. Water In Soils

ASSESSING THE SUITABILITY OF SOILS WITH MACROPORES FOR SUBSURFACE LIQUID WASTE DISPOSAL,
Stichting voor Bodemkartering, Wageningen (Netherlands).
For primary bibliographic entry see Field 5D.
W84-01805

PASSIVE MICROWAVE SENSING OF SOIL MOISTURE CONTENT: THE EFFECTS OF SOIL BULK DENSITY AND SURFACE ROUGHNESS,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
J. R. Wang.
Remote Sensing of Environment, Vol. 13, No. 4, p 329-344, September, 1983. 8 Fig, 1 Tab, 25 Ref.

Descriptors: *Soil water, *Radiometry, *Measuring instruments, Soil density, Physical properties, Remote sensing.

Microwave radiometric measurements over bare fields of different surface roughness were made at frequencies of 1.4 GHz, 5 GHz, and 10.7 GHz to study the frequency dependence, as well as the possible time variation, of surface roughness. An increase in surface roughness was found to increase the brightness temperature of soils and reduce the slope of regression between brightness temperature and soil mositure content. The frequency dependence of the surface roughness effect was relatively weak when compared with that of the vegetation effect. Radiometric time-series observations over a given field indicate that field surface roughness might gradually diminish with time, especially after a rainfall or irrigation. The variation of surface roughness increases the uncertainty of remote soil moisture estimates by microwave radiometry. Three years of radiometric measurements over a test site revealed a possible inconsistency in the soil bulk density determination, which is an important factor in the interpretation of radiometric data. (Author's abstract)
W84-01852

CALCULATION OF SORPTIVITY FROM CONSTANT-RATE RAINFALL INFILTRATION MEASUREMENT,
Southern Illinois Univ. at Carbondale. Dept. of Forestry.
S.-K. Chong.
Soil Science Society of America Journal, Vol. 47, No. 4, p 627-630, July-August, 1983. 3 Fig, 21 Ref.

Descriptors: *Ponding, *Rainfall infiltration, *Sorptivity, Rainfall-runoff relationships, Permeability coefficient, Soil hydraulics, Hawaii.

Incipient ponding time equations were rearranged and used for calculating sorptivity under constant-rate rainfall conditions. The equations were tested using the field-measured data obtained in Hawaii. The incipient ponding time is assumed equal to the time of first appearance of runoff from the experimental plot. Additionally, the A value in the Philip two-term infiltration equation is assumed to be Ksat/3. The sorptivity values calculated from both equations have only a 1.22% difference. The accuracy of the calculated sorptivity was assessed by its use for predicting infiltration. In the comparison of cumulative infiltration, the correlation coefficient between measured and estimated values is > 0.9 with a mean error percentage of 20.09 and a median of 10.57%. The equation requires information on rainfall intensity, saturated hydraulic conductivity, and the incipient ponding time. Even though the time to incipient ponding and the time of first appearance of runoff were different, the assumption that they are equal is acceptable for runoff plots within uniform slopes. Using rainfall infiltration to measure sorptivity is impractical since the experiment requires tremendous time and labor. It is possible to calculate sorptivity from the simulated rainfall-runoff experiment. (Moore-IVI)
W84-01863

SOIL WATER DIFFUSIVITY NEAR SATURATION,
Department of Scientific and Industrial Research, Palmerston North (New Zealand). Div. of Plant Physiology.
B. E. Clothier, and R. A. Wooding.
Soil Science Society of America Journal, Vol. 47, No. 4, p 636-640, July-August, 1983. 6 Fig, 18 Ref.

Descriptors: *Soil water, *Diffusivity, *Soil saturation, *Water retention, Moisture tension, Permeability coefficient, Soil absorption capacity.

Many laboratory porous materials are considered to have a zone of tension-saturation in their water retentivity curve near saturation, which implies that the soil water diffusivity, D, is infinite in such a region. Three new methods of measuring the diffusivity near saturation are presented. The soil used in all experiments was the fine sand-textured C horizon of Manawatu fine sandy loam, a Dystric Fluventic Eutrochrept. All methods found D to be finite, yet large, having a value of approximately 0.001 to 0.002 sq m/s. Since the near-saturated conductivity of the sand is of the order 10 to the -5 m/s this implies that the water retentivity curve near saturation has a finite but large slope of order 100 m. This was compatible with the measured retentivity data. The theory of one-dimensional absorption implies that the slope of the Boltzmann variable with respect to volumetric water content near saturation equals twice D divided by the sorptivity. The slope calculated this way was compatible with that found in absorption experiments. (Moore-IVI)
W84-01864

EFFECT OF SYNTHETIC CONDITIONERS ON SOIL WATER RETENTION, HYDRAULIC CONDUCTIVITY, POROSITY AND AGGREGATION,
American Univ., Beirut (Lebanon). Dept. of Soils, Irrigation and Mechanization.
For primary bibliographic entry see Field 3F.
W84-01865

EFFECT OF SLOPE ON WATER BALANCE UNDER CENTER-PIVOT IRRIGATION,
Nebraska Univ.-Lincoln. Dept. of Agronomy.
A. Y. Hanna, P. W. Harlan, and D. T. Lewis.
Soil Science Society of America Journal, Vol. 47, p 760-764, July-August, 1983. 3 Fig, 5 Tab, 10 Ref.

Descriptors: *Soil water, *Slope, *Center-pivot irrigation, Water storage, Water balance, Surface runoff, Soil infiltration, Evapotranspiration, Corn, Sprinkler irrigation, Soil drainage, Rainfall-runoff relationships, Nebraska, Gage County.

The effects of slope on water storage and other water balance components under center-pivot irrigation were studied in Gage County, Nebraska. Soil water, surface runoff, precipitation, and irrigation were measured for soils of low infiltration on slopes of 2, 4, and 8% under corn (Zea mays L.). Evapotranspiration was calculated. Soil water content (0- to 137-cm depth) during the growing season was higher in soils on 8% slopes than in soils on slopes of 2 and 4%. Runoff from all slopes was not associated with sprinkler irrigation in the crop production system studied. As slope increased, surface runoff caused by rain increased, and internal drainage beyond the 137-cm depth decreased at approximately the same rate. The overall water depletion during the growing season was not significantly affected by slope. (Author's abstract)
W84-01868

MODELS FOR ESTIMATING IN-SITU POTENTIAL EXTRACTABLE WATER USING SOIL PHYSICAL AND CHEMICAL PROPERTIES,
Texas Agricultural Experiment Station, College Station.
D. K. Cassel, L. F. Ratliff, and J. T. Ritchie.
Soil Science Society of America Journal, Vol. 47, No. 4, p 764-769, 1983. 2 Fig, 4 Tab, 15 Ref.

Descriptors: *Soil properties, *Moisture availability, Soil water, Physical properties, Chemical properties, Model studies, Estimating.

Accurate evaluation of the upper and lower limits of soil water availability is vital for accurate computation of the water balance in marginally dry regions. Empirical equations were developed for calculation of the limits of in situ potential extractable soil water using routinely measured soil properties. Physical and chemical properties were determined on samples collected from depth increments coinciding with measurements of extractable water limits. The potential extractable water calculated as the difference between the upper and lower limits based upon the equations developed was correlated with measured plant extractable water for the different levels of input information and textural separations. The coefficients of determination for potential extractable water ranged from 0.375 for the two-variable input level with no textural separation to 0.758 for the 10-input level with three textural separations. Standard deviation for the latter, best correlated system to estimate potential extractable water was about 2 percentage units when compared with field measured extractable water. (Baker-IVI)
W84-01869

FIELD-MEASURED LIMITS OF SOIL WATER AVAILABILITY AS RELATED TO LABORATORY-MEASURED PROPERTIES,
Texas Agricultural Experiment Station, College Station.
L. F. Ratliff, J. T. Ritchie, and D. K. Cassel.
Soil Science Society of America Journal, Vol. 47, No. 4, p 770-775, July-August, 1983. 6 Fig, 3 Tab, 9 Ref.

Descriptors: *Soil water, *Water availability, Crops, Water supply, Soil properties.

The accurate evaluation of soil water reserves available for plant use is vital in developing optimum water management for crop production in marginally dry regions. A comprehensive data base of field measured upper and lower limits of soil water reservoir was obtained and evaluated. The field measured upper limit was taken as the water content at which drainage from a prewetted soil had practically ceased. The lower limit was taken as the water content of the soil at which plants were practically dead or dormant as a result of the soil water deficit. Variation often existed within a soil series at a particular site for the field measured upper and lower limits. However, the differences between the field-measured limits, the total available water reservoir, were relatively constant. Crop species caused only minor differences in the lower limit water content for the upper part of the soil profile where root length density was apparently above some critical level. However, some annuals extracted water to greater depths than others. If absolute accuracy is necessary in water balance calculations, laboratory estimated soil water limits should be used with caution and field measured limits would be preferred. (Baker-IVI)
W84-01870

WATER BUDGET OF AN EASTERN DECIDUOUS FOREST STAND,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2I.
W84-01871

CHARACTERIZING UNSATURATED HYDRAULIC CONDUCTIVITY OF WESTERN KENTUCKY SURFACE MINE SPOILS AND SOILS,
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
A. Ward, L. G. Wells, and R. E. Phillips.
Soil Science Society of America Journal, Vol. 47, No. 5, p 847-855, September-October, 1983. 9 Fig, 2 Tab, 21 Ref.

Descriptors: *Permeability coefficient, *Soil infiltration, *Spoil banks, *Mine wastes, *Strip mine wastes, Mathematical models, Soil water, Soil saturation.

A large-scale laboratory infiltrometer system was used to determine infiltration characteristics of 'reconstructed' surface mine spoil and soil horizons. Soil water characteristic curves were determined using the Brooks-Corey and the Gardner procedures and developed based on desorption tensiometer data. Unsaturated hydraulic conductivity values were determined using the 'plane of zero flux' procedure and compared with predictions resulting from models described by Campbell, Burdine, and Mualem for situations involving reconstructed soil and spoil materials. There was generally good agreement between the models and excellent agreement between Campbell's predictions and plane of zero flux results. Both the Gardner equation and the Brooks-Corey equation gave good estimates of the soil water characteristic curves for the materials. The physical significance of the parameters Theta sub r, and Psi sub e when determined by statistical procedures, appears very questionable. In this study, the final steady-state infiltration rate appeared to be a good estimate of the hydraulic conductivity at apparent saturation. (Author's abstract)
W84-01872

PULSED TRICKLING EFFECTS ON SOIL MOISTURE DISTRIBUTION,
Illinois Univ. at Urbana-Champaign.
For primary bibliographic entry see Field 3F.
W84-01946

2H. Lakes

LAKE TEMPERATURE DYNAMICS IN HYBRID COOLING SYSTEM,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
T. W. Sturm, J. M. Fulford, and K. J. Fay.
Journal of Environmental Engineering, Vol. 109, No. 3, p 668-684, June, 1983. 10 Fig, 24 Ref. NSF grant ENG78-21957.

Descriptors: *Cooling lakes, *Simulation, *Thermal properties, Thermal pollution, Solar heating, Cooling water, Wind, Advection, Diffusion, Water temperature, Thermal stratification, Water circulation, Epilimnion, Indiana.

A transient thermal simulation model of a hybrid cooling lake is developed to assess the impact of cooling water withdrawals and cooling tower discharges on the thermal structure of the lake. The model is based on one-dimensional mechanical and thermal energy balances and includes the physical processes of solar heating, wind stirring, vertical advection, and hypolimnetic diffusion. Temperature data were collected on two small lakes in northern Indiana, and the simulated temperatures are compared with the measured data for the lake stratification seasons of 1976 and 1978. Cooling water circulations significantly thicken the epilimnion due to vertical advection of heat. This is confirmed by the observed variation of three dimensionless parameters which characterize the essential physical processes that affect the lake thermal structure. These parameters are a wind Richardson number, a withdrawal densimetric Froude number, and a dimensionless surface buoyancy flux. The simulation model can be used to quantify the thermal response of the lake due to a change in the withdrawal densimetric Froude number while the other two dimensionless parameters remain unchanged. (Moore-IVI)
W84-01772

LANDSAT IMAGERY FOR ASSESSING CHANGES IN LAKE AREAS AT DUNGENESS, ON THE KENT COAST,
T. Keating.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 4, p 290-294, August, 1983. 4 Fig, 1 Tab.

Descriptors: *Lakes, *LANDSAT, *Satellite technology, Hydrogeology, Dungeness, England, Remote sensing.

The hydrogeology of the Dungeness shingle beach is being studied. The beach is the major source of concreting aggregate in southeast England, and gravel extraction below the water table has led to the development of lakes. The growth of the lakes has been monitored using conventional aerial photography and images from the LANDSAT earth resources satellite. The areas of the three major lakes as deduced from the LANDSAT images are shown along with the total open water area on the beach. The aerial surveys of the beach were undertaken on July 18, 1972, June 19, 1977 and October 13, 1981 at scales of 1:22,000, 1:75000 and 1:5000, respectively. The open water areas have been deduced from these aerial photographs manually. The 1978 LANDSAT data and aerial survey data are for dates only 60 days apart, which provides a measure of the accuracy of the LANDSAT data. The two estimates of total open water area differ by only 5%. The aerial survey data are also given. Overall, these figures show that the second lake remained relatively unchanged over the 10 year period, while the other lakes have undergone considerable changes. The development of one lake as deduced from the LANDSAT data is shown. (Baker-IVI)
W84-01818

FIRST FILLING OF KIELDER RESERVOIR AND FUTURE OPERATIONAL CONSIDERATIONS,
For primary bibliographic entry see Field 4A.
W84-01819

NUTRIENT RETENTION AND TRANSFORMATION IN RELATION TO HYDRAULIC FLUSHING RATE IN A SMALL IMPOUNDMENT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
R. R. Turner, E. A. Laws, and R. C. Harris.
Freshwater Biology, Vol. 13, No. 2, p 113-127, April, 1983. 3 Fig, 9 Tab, 50 Ref.

Descriptors: *Impoundments, *Nutrients, Cycling nutrients, Silicates, Phosphates, Phytoplankton, Productivity, Population dynamics, Lake Talquin, Florida.

The fluxes of water, chloride, silicate and various forms of nitrogen and phosphorus into and out of a 3925 ha impoundment (Lake Talquin) in north Florida were examined over a 3 year period. Annual hydraulic flushing rates for the lake varied by a factor of more than 2 during the study period and provided an opportunity to examine the effect of flushing rate on nutrient cycling within the lake. The results support the hypothesis that nutrient retention and transformation in lakes and impoundments with high flushing rates (>1/year) are appreciably influenced by annual variations in flushing rates. Higher fractions of input silicate and total phosphorus were retained by Lake Talquin during the years with average flushing rates (8/year) than during a year with abnormally high flushing rate (16/year). Nitrogen was not appreciably retained during any of the three study years, and thus N:P ratios in the lake outflow were higher than in the inflow. Phytoplankton productivity was appreciably higher (70%) during the year with the higher flushing rate, apparently in response to higher reactive phosphorus concentrations in the lake and perhaps to a higher standing crop of phytoplankton during that year. Reactive phosphorus and dissolved inorganic nitrogen inputs could account for only about 30% and 25%, respectively, of the phosphorus and nitrogen required to support observed photosynthetic rates in all three study years. Recycling of nutrients apparently accounted for most of the remainder, although nitrogen fixation could not be ruled out as a factor in the nitrogen budget. (Author's abstract)
W84-01831

INFLUENCE OF ELEVATED NITRATE CONCENTRATION ON RATE OF LEAF DECOMPOSITION IN A STREAM,
Georgia Univ., Athens. Dept. of Zoology.
J. L. Meyer, and C. Johnson.
Freshwater Biology, Vol. 13, No. 2, p 177-183, April, 1983. 5 Fig, 2 Tab, 25 Ref.

Descriptors: *Organic matter, *Litter, *Decomposition, Forest watersheds, Nutrients, Streams, Nitrates, Phosphorus, Nitrogen, Environmental effects, Ecosystems.

Leaf decomposition was compared in two streams at the Coweeta Hydrologic Laboratory, North Carolina. One stream drains an undistributed hardwood watershed, while the other drains a successional watershed subject to an insect outbreak. The successional watershed has elevated nitrate concentrations in the streamwater. Both black locust (Robinia pseudo-acacia) and sweet birch (Betula lenta) leaf litter decomposed 2.8 times more rapidly in the stream with high nitrate concentrations. The more rapid decay rates appeared to be partly due to accelerated microbial processing in response to nitrate enrichment, because microbial biomass (as ATP) was higher in the nitrate-enriched stream. At each point in time, nitrogen and phosphorus content of the litter was lower in the high nitrate stream; however, there was no significant difference in nitrogen or phosphorus content at the same state of leaf decay in the two streams. Natural watershed disturbances such as insect infestations or anthropogenic disturbances such as clear cutting, by increasing the nitrate content of stream water, can alter rates of detrital processing in streams. In a detritus-based ecosystem a change in detrital processing rates could profoundly affect stream ecosystem function. (Baker-IVI)
W84-01832

CONTINUOUS AMMONIUM ENRICHMENT OF A WOODLAND STREAM: UPTAKE KINETICS, LEAF DECOMPOSITION, AND NITRIFICATION,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. D. Newbold, J. W. Elwood, M. S. Schulze, R. W. Stark, and J. C. Barmeier.
Freshwater Biology, Vol. 13, No. 2, p 193-204, April, 1983. 6 Fig, 4 Tab, 36 Ref.

Descriptors: *Streams, *Sediments, *Ammonium, *Enrichment, Nitrification, Nitrogen, Adsorption, Benthic environment, Nitrates, Tennessee, Walker Branch.

In order to test for nitrogen limitation and examine ammonium uptake by stream sediments, ammonium hydroxide was added continuously at concentrations averaging 100 micrograms/liter for 70 days to a second-order reach of Walker Branch, an undisturbed woodland stream in Tennessee. Ammonium uptake during the first 4 hr of addition corresponded to adsorption kinetics rather than to first-order uptake or to Michaelis-Menten kinetics. However, the calculated adsorption partition coefficient was two to four orders of magnitude greater than values reported for physical adsorption of ammonium, suggesting that the uptake was largely biotic. Mass balance indicated that the uptake of ammonium from the water could be accounted for by increased nitrogen content in benthic organic detritus. Nitrification, inferred from longitudinal gradients in NO3, began soon after enrichment and increased dramatically near the end of the experiment. Both ammonium and nitrate concentrations dropped quickly to near background levels when input ceased, indicating little desorption or nitrification of excess nitrogen stored in the reach. There was no evidence of nitrogen limitation as measured by weight loss, oxygen consumption, phosphorus content, and macroinvertebrate density of red oak leaf packs, or by chlorophyll content and aufwuchs biomass on plexiglass slides. A continuous phosphorus enrichment 1 year earlier had demonstrated phosphorus limitation in Walker Branch. (Author's abstract)
W84-01833

PHOSPHORUS AND CALCIUM CARBONATE SOLUBILITIES IN LAKE KINNERET,
Technion - Israel Inst. of Tech., Haifa.
Y. Avnimelech.
Limnology and Oceanography, Vol. 28, No. 4, p 640-645, July, 1983. 2 Fig, 2 Tab, 19 Ref.

Descriptors: *Lakes, *Chemical properties, Algal growth, Phosphates, Calcium, Nutrients, Lake Kinneret, Calcium carbonate.

Phosphate and calcium carbonate solubilities were calculated from data obtained for near-bottom water samples from Lake Kinneret during the years 1975-1977. A potential diagram technique was used to determine which solid phase is in equilibrium with the solution. Both phosphorus and calcium carbonate solubilities are controlled, during the January-August period, through equilibrium with calcium-carbonate-phosphate. The calcium carbonate ionic product changes, depending on the phosphoric acid potential, during this period. Calcium carbonate activity is constant during the last months of the stratified period (September-December). These findings support the hypothesis that the first and most reactive product of the reactions occurring between calcium carbonate and phosphorus is a CaCO3H3PO4 surface complex. (Baker-IVI)
W84-01836

EFFECTS OF REGULATION OF THE RIVER TEES UPON FISH POPULATIONS BELOW COW GREEN RESERVOIR,
D. T. Crisp, R. H. K. Mann, and P. R. Cubby.
Journal of Applied Ecology, Vol. 20, No. 2, p 371-386, August, 1983. 4 Fig, 13 Tab, 13 Ref.

Descriptors: *Fish populations, *Reservoirs, *Environmental effects, Seasonal variation, Population density, Green reservoir, River Tees.

The population density, growth, biomass, fecundity and production of bullhead (Cottus gobio) and brown trout (Salmo trutta) were estimated in the River Tees below the regulating reservoir at Cow Green. Comparisons were made with estimates obtained for the same site before impoundment, and with data from Maize Beck, and unregulated tributary of the Tees below the reservoir. Changes in the growth of trout were negligible, but there was an apparent decrease in the observed lengths of O group bullheads in the regulated Tees. This may reflect a shorter growing season because bullheads spawned later in the Tees after impoundment, possibly in response to the delay in the increase in water temperature during the spring. There were marked annual variations in the numbers of brown trout and bullhead, but population

densities of both species increased in the Tees following regulation. The numbers of both species were significantly higher in the Tees than in Maize Beck during both periods. The annual instantaneous mortality rate of bullheads increased from 0.67 to 1.30 in the Tees following impoundment; corresponding values for Maize Beck were 0.68 and 0.81. The mean fecundity of individual female bullheads of any given size decreased in the Tees, but remained the same in Maize Beck. The increase in population density in the Tees caused a significant increase in the number of eggs laid each year by the whole population from 3.70 to 8.42 eggs/sq m. The corresponding values in Maize Beck of 2.04 and 2.28 eggs/sq m were not significantly different. Only very approximate values were obtained for annual production of trout. Estimated bullhead production increased slightly at Maize Beck and by a factor of three in the Tees. Annual production by older fish changed little. The combination of environmental changes caused by regulation has improved conditions for the downstream fish populations. This has been exploited by the bullheads and trout mainly through increased population density and population biomass, rather than through any marked increased in the growth rate of individual fish. This would be expected because growth rate appears to be limited mainly by water temperature. (Baker-IVI)
W84-01837

FISH OF CHANNELIZED AND UNCHANNELIZED SECTIONS OF THE BUNYIP RIVER, VICTORIA,
James Cook Univ. of North Queensland, Townsville (Australia). School of Biological Sciences.
K. G. Hortle, and P. S. Lake.
Australian Journal of Marine and Freshwater Research, Vol. 34, No. 3, p 441-450, 1983. 1 Fig, 6 Tab, 26 Ref.

Descriptors: *Fish population, *Channeling, *Environmental effects, Rivers, Streams, Population density, Bunyip River, Australia.

The distribution and abundance of fish at three channelized and three unchannelized sites on the Bunyip River in southern Victoria were investigated. Ten species of native fish, including the Australian grayling (Prototroctes maraena), and two species of introduced fish were collected in three sets of seasonal samples by electrofishing. The unchannelized sites and a channelized site directly above a small weir had significantly higher species richness, total fish biomass, numerical density and standing crop than the other two channelized sites. Ammocoete lamprey larvae, short-finned eels, southern pigmy perch and brown trout were most abundant at the unchannelized sites, whereas the common jollytail was most abundant at the channelized sites. Total numbers and biomass of fish and species richness were all positively correlated with the area of snags present, and species richness and fish biomass correlated positively with the area of slack water. It appears that the absence of suitable habitat (viz, area of snags, area of slack water, length of bank fringed with vegetation) accounts for the lower abundance and lower species richness of fish after channelization. A small weir at one of the channelized sites ameliorated partly the effects of channelization. (Author's abstract)
W84-01839

EARLY EUTROPHICATION IN THE LOWER GREAT LAKES: NEW EVIDENCE FROM BIOGENIC SILICA IN SEDIMENTS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
C. L. Schelske, E. F. Stoermer, D. J. Conley, J. A. Robbins, and R. M. Glover.
Science, Vol. 222, No. 4621, p 320-322, October, 1983. 2 Fig, 1 Tab, 27 Ref.

Descriptors: *Eutrophication, *Lakes, Diatoms, Sedimentation, Nutrients, Great Lakes, Lake Ontario, Lake Erie, Lake Michigan.

New evidence from studies of biogenic silica and diatoms in sediment cores related to eutrophication in the lower Great Lakes is presented. Diatom production peaked from 1820 to 1850 in Lake Ontario, at about 1880 in Lake Erie, but not until 1970 in Lake Michigan. The biogenic silica data from Lake Michigan and Lake Ontario cores indicate that the silica-depletion sequence occurred over a relatively short period of time, possibly as little as 20 to 40 years. This short time course shows that silica dynamics and mass-balance relations can be affected significantly and rapidly by biological effects of nutrient enrichment. Silica-limited steady states have developed in Lake Ontario and Lake Erie and possibly since 1970 in Lake Michigan. Lake Huron with recent increases in BSI storage may be in a transition between steady states whereas silica dynamics have been affected least in Lake Superior where phosphorus enrichment has been least. (Baker-IVI)
W84-01840

FISH COMMUNITIES ALONG ENVIRONMENTAL GRADIENTS IN A SYSTEM OF TROPICAL STREAMS,
Illinois Univ. at Urbana-Champaign. Dept. of Ecology, Ethology and Evolution.
P. L. Angermeier, and J. R. Karr.
Environmental Biology of Fishes, Vol. 9, No. 2, p 117-135, September, 1983. 10 Fig, 6 Tab, 46 Ref.

Descriptors: *Forests, *Streams, *Fish populations, Rainfall, Topography, Benthic environment, Behavior, Nutrients, Tropical regions, Panama, Trophic level.

Fish community structure was examined in 9 forested streams (1-6 m wide) in central Panama during dry seasons over a 3 year period. Study regions varied in annual rainfall, degree of canopy shading, and topographical relief. Benthic invertebrates were more abundant in riffles than in pools and more abundant in eary (January) than late (March) dry season. In addition, benthos abundances were negatively correlated with canopy shading among study regions. Terrestrial invertebrate abundances were greater in January than March and were correlated with stream width. Fishes were assigned to 7 feeding guilds (algivores, aquatic insectivores, general insectivores, piscivores, scale-eaters, terrestrial herbivores, omnivores) on the basis of similarity of gut contents. Four species exhibited marked dietary shifts with increasing size. Distributions of feeding guilds (biomass) among habitats and streams were not generally correlated with availabilities of their major food resources. All feeding guilds except aquatic insectivores were most concentrated (biomass per area) into deep pools. Densities of algivores and terrestrial herbivores increased with stream size, but the density of aquatic insectivores declined. Species richness of feeding guilds increased with stream size and canopy openness. The proportion of fish biomass supported by algae and terrestrial plant material increased with stream size, while that supported by aquatic and terrestrial invertebrates declined. Small fishes (< 40 mm TL) were most abundant in pools of small streams. Terrestrial predators appeared to be more important than food availability in determining distributions of fish among habitats. However, trophic diversity of fish communities may be related to the reliability of available food resources. (Author's abstract)
W84-01842

LEAF PROCESSING IN TWO CONTRASTING BEECH FOREST STREAMS: EFFECTS OF PHYSICAL AND BIOTIC FACTORS ON LITTER BREAKDOWN,
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
J. S. Rounick, and M. J. Winterbourn.
Archiv fur Hydrobiologie, Vol. 96, No. 1, p 448-474, April, 1983. 8 Fig, 4 Tab, 53 Ref.

Descriptors: *Organic matter, *Streams, *Litter, Forests, Forest watersheds, Biodegradation, New Zealand.

Changes in dry weight, protein and oxygen consumption of mountain beech leaves held in mesh bags in two New Zealand streams were investigated and interpreted in relation to the contrasting physical and faunal chacteristics of the streams. Weight losses were most rapid in coarse-mesh (3 mm) bags incubated in Middle Bush Stream, a relatively stable stream with a large population of shredders. In contrast, leaf breakdown rate in coarse-mesh bags held in Craigieburn Cutting Stream, a more unstable stream with few shredders was similar to that recorded in fine mesh (0.2 mm) containers in both streams. Leaves in bags buried in the beds of both streams lost weight more slowly than their surface counterparts and had slightly lower protein levels and respiration rates. Larvae of the caddisfly, Zelandopsyche ingens were primarily responsible for the rapid disappearance of beech leaves in Middle Bush Stream. Although apparently absent from Craigieburn Cutting Stream, cage experiments showed that larvae grew and survived equally well in both streams. Absence of Z. ingens from Craigieburn Cutting Stream is attributed to the inability of the stream to retain coarse particulate organic inputs. Retention appears to be the key to shredder abundance and hence a major factor controlling litter breakdown. In streams with poor retention capacities, the organic layers which develop on stone surfaces are the most important sites of carbon transfer to the benthos. (Baker-IVI)
W84-01844

ENERGY FLOW, TROPHIC EVOLUTION AND ECOSYSTEM MANAGEMENT OF A KASHMIR HIMALAYAN LAKE,
Central Inland Fisheries Research Inst., Harwan (India).
K. K. Vass, and D. P. Zutshi.
Archiv fur Hydrobiologie, Vol. 97, No. 1, p 39-59, May, 1983. 2 Fig, 5 Tab, 70 Ref.

Descriptors: *Phytoplankton, *Lakes, *Ecosystems, Productivity, Zooplankton, Photosynthesis, Kashmir, Dal Lake.

Dal Lake is situated in an urban environment and thus exposed to undesirable human influences which threaten its existence. The efficiency of energy utilization at various trophic levels of the lake has been studied. In Dal Lake ecosystem it has been observed that through photosynthesis the system fixes about 1009 g out of which only 11% is contributed by phytoplankton and 88% by macrophytes. Periphyton accounts for less than 1% of primary production. Respiratory losses are quite high and on a yearly basis it comes to 69%. Zooplankton fix about 0.41 g carbon/sq m/yr while fish harvest amounts to 0.165 g carbon/sq m/yr and 312.7 g carbon/sq m/yr are returned back to lake bottom. The conversion efficiency between primary producers and zooplankton is 0.17% and between former and fish it is 0.019%. Benthic population of the lake is insignificant. Thus most of the energy fixed by macrophytes is unutilized. In order to make good use of this component, introduction of grass carp is desirable. (Baker-IVI)
W84-01847

LIGHT INTENSITY AND RELATIVE LIGHT CHANGES AS FACTORS REGULATING STREAM DRIFT,
New Hampshire Univ., Durham. Dept. of Zoology.
J. F. Haney, T. R. Beaulieu, R. P. Berry, D. P. Mason, and C. R. Miner.
Archiv fur Hydrobiologie, Vol. 97, No. 1, p 73-88, May, 1983. 5 Fig, 2 Tab, 18 Ref.

Descriptors: *Light intensity, *Mayflies, Behavior, Daphnia, Population dynamics, Behavior, Drift.

Studies were conducted in two woodland streams to evaluate the importance of light intensity and relative rate of light change on the timing and density of mayfly drift. Under natural conditions light intensity ranged from 1.0-12.9 micro W/sq cm and relative light change from -.0024 to -.0036/sec at the time of the initiation of evening drift (EDI). When light intensity was reduced 85% by covering a section of the stream, light intensity at EDI was also lower and the timing of drift shifted, despite little difference in the relative light change. A model of light control of evening drift is proposed that involves the interaction of photokinetic

activity regulated by the relative change in light and phototactic behavior controlled by light intensity. The effect of moonlight on the pattern of drift appeared to be related to the relative rate of change in moonlight, rather than its absolute intensity. A model of light control of EDI is proposed which includes a photokinetic activity regulated by the relative light change and a phototactic behavior controlled by light intensity. An empirical linear regression model was developed using the results of the study to predict the time of initiation of drift based on light intensity and time of the relative light change threshold. (Baker-IVI)
W84-01848

INTERPRETATION OF PHOSPHORUS LOADINGS IN DYSTROPHIC LAKES,
Erindale Coll., Mississauga (Ontario).
P. Chow-Fraser, and H. C. Duthie.
Archiv fur Hydrobiologie, Vol. 97, No. 1, p 109-121, May, 1983. 2 Fig, 3 Tab, 45 Ref.

Descriptors: *Dystrophic lakes, *Phosphorus, Model studies, Biomass, Chlorophyll, Canadian Shield, Phytoplankton.

Application of the model sequence of Vollenweider (1969) and Dillon and Rigler (1974) relating phosphorus loading to phytoplankton biomass was investigated on a basin of a dystrophic Canadian Shield Lake. A phosphorus budget was estimated using field measurements, and was subsequently used to predict the spring P concentration (P-spr). An observed (P-spr) was then employed to predict the mean summer (chlor-a). Comparisons were made between these predicted values and observed concentrations. Results of these comparisons indicated that whereas the P-budget could accurately predict (P-spr) grossly over-estimated (chlor-a). This implies that the use of P-loading models for outlining permissible and critical loadings may not apply to dystrophic systems and that alternate methods should be investigated. While total phosphorus measurements are useful in year-to-year comparisons of the same lake in similar lake types, discretion is advised in making lake-to-lake extrapolations. (Baker-IVI)
W84-01849

ROLE OF SUSPENDED SEDIMENTS IN THE NUTRITION OF ZOOPLANKTON IN TURBID RESERVOIRS,
Kansas State Univ., Manhattan. Div. of Biology.
J. A. Arruda, G. R. Marzolf, and R. T. Faulk.
Ecology, Vol. 64, No. 5, p 1225-1235, October, 1983. 7 Fig, 4 Tab, 65 Ref.

Descriptors: *Zooplankton, *Reservoirs, *Turbidity, Organic matter, Adsorption, Aquatic life, Nutrients, Daphnia.

Reservoirs built on rivers draining agricultural watersheds are often turbid with suspended sediments. Filter-feeding zooplankton, e.g., members of the genus Daphnia, seem to be as abundant in such reservoirs as in natural lakes. Using controlled laboratory conditions, the potential role of suspended sediments in the nutrition of Daphnia from a turbid reservoir was investigated. In three sets of experimental procedures measurements were made of: (1) the physical effect of sediments on the ingestion and incorporation rates of algae by daphnids, (2) the ingestion rates of two sizes of clay mineral sediment particles by daphnids, and (3) the growth and survival of daphnids fed yeast and sediments with and without organic matter adsorbed onto the particle surfaces. Increases in suspended sediment concentration from 0.0 to 2451 mg/L decreased ingestion rates of 14C-labeled Chlorella vulgaris by Daphnia parvula and D. pulex by about 95% and decreased incorporation rates by 99%. Sediment concentrations of 50-100 mg/L reduced the algal carbon ingested by daphnids to potential starvation levels. 65Zn-labeled fine and coarse (1.88 and 4.65 micrometer mean diameter) clay mineral sediment particles were fed to D. parvula, D, pulex, and D. similis. Ingestion rates of sediments by daphnids were limted at particle concentrations of about 5000000 particles/mL and were dependent on particle size, daphnid species, and body size. Fine particles were ingested at greater rates by D. pulex and D. parvula than were coarse particles, while large D. similis ingested coarse and fine particles at similar rates. In addition, D. pulex had higher ingestion rates in each particle size suspension than did D. parvula or D. similis. The differential ability to ingest these particles suggests a mechanism of regulating daphnid species composition if the organic matter adsorbed to these sediment particles is useful as food. To evaluate this mechanism, dissolved organic protein was adsorbed to sediment particles. When D. pulex were fed the amended sediment suspension, they grew larger than when fed control sediments, but not as large as when fed yeast. D. parvula grew equally well when fed either yeast or amended sediments. Thus, dissolved organic matter can be made available for daphnic growth by the mechanism of adsorption. (Baker-IVI)
W84-01850

A METHOD FOR THE REDUCTION OF LAKE MODEL PREDICTION ERROR,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
K. H. Reckhow.
Water Research, Vol. 17, No. 8, p 911-916, August, 1983. 1 Fig, 11 Ref.

Descriptors: *Lakes, *Error analysis, *Water quality, *Model studies, Water quality control, Phosphorus, Land use.

Recent work on methods of error analysis to accompany the application of lake models has not enjoyed great acceptance in part because of the magnitude of the error term. For the models that have undergone a rigorous error analysis, prediction errors for various water quality variables are often 30% or more. A procedure is proposed for the reduction of the error associated with the prediction of lake phosphorus concentration from land use and hydrologic data. Existing lake quality data are used in the prediction, and the model is employed only to project changes from the present state. This obviates the need to project all land use impacts with the model. Only those proposed to change are projected. The result is a substantial reduction in prediction error for many planning scenarios. (Baker-IVI)
W84-01903

EFFECT OF ACIDIFICATION, METALS AND METALLOIDS ON SEDIMENT MICROORGANISMS,
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W84-01904

DYNAMIC BACTERIAL MODEL FOR A RECREATIONAL LAKE,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W84-01943

LIGHT-PRODUCTIVITY MODEL FOR ONONDAGA LAKE, N.Y.,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
S. D. Field, and S. W. Effler.
Journal of Environmental Engineering, Vol. 109, No, 4, p 830-844, August, 1983. 6 Fig, 1 Tab, 35 Ref.

Descriptors: *Primary productivity, *Light, New York, Onondaga Lake, Hypereutrophic lakes, Mathematical models, Photosynthesis, Water temperature, Chlorophyll a, Nutrients, Light attenuation, Seasonal variation, Quantum yield.

Two models were calibrated to the 1978 primary productivity conditions of nutrient-rich hypereutrophic Onodaga Lake, N.Y.; one was based on the approach of Bannister (Limnology and Oceanography, Vol. 19, 1974, p 1-12), the other on a more conventional format. The data base, necessary for model development, included continuously monitored incident photosynthetically active radiation (PAR), and 115 parallel measurements of water column temperature, PAR attenuation, chlorophyll a, primary productivity, and key nutrients. Values of key parameters for the Bannister model, obtained by evaluation of the data set, differed from those recommended in the literature. Both models effectively predicted seasonal and short-term trends in primary productivity for most of the study, though the Bannister model was slightly better. The Bannister model predictions were particularly sensitive to estimates of the maximum quantum yield of photosynthesis. The Bannister model is preferred on theoretical grounds, since it incorporates more fundamental and more constant parameters, and more properly accounts for temperature influences. (Author's abstract)
W84-01954

PRIMARY PRODUCTIVITY IN A LARGE, TEMPERATE LAKE WITH RIVER INTERFLOW: KOOTENAY LAKE, BRITISH COLUMBIA,
National Water Research Inst., Vancouver (British Columbia).
S. Jasper, E. C. Carmack, R. J. Daley, C. B. J. Gray, and C. H. Pharo.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 3, p 319-327, March, 1983. 8 Fig, 1 Tab, 34 Ref.

Descriptors: *Phytoplankton, *Productivity, *Kootenay Lake, British Columbia, Chlorophyll, Water temperature, Photosynthesis, Euphotic zone, Light, Nutrients, River inflow, Stratification.

Phytoplankton productivity in a large, deep lake with river interflow was determined using an incubator method modified to include vertical distributions of chlorophyll and temperature together with continuous surface irradiance measurements. The annual average areal production, in 1977, was 170 g C/sq m with daily areal productions ranging from 100 to 2800 mg C/sq m. P max for all samples correlated well with chlorophyll a ($r=0.79$). No large horizontal trends in areal productivity or Pmax were found in the lake at any time of the year. However, pronounced differences with depth in the photosynthetic characteristics of populations within the euphotic zone were common during the stratified season. The two large inflowing rivers are thought to be important to the productivity of Kootenay Lake as they initiate the spring production peak and supply nutrients to the deeper phytoplankton populations during the summer and fall period.
W84-01972

EFFECTS OF CHANGES IN PH ON TRANSPARENCY AND THERMAL REGIMES OF LOHI LAKE, NEAR SUDBURY, ONTARIO,
Ontario Ministry of the Environment, Rexdale. Limnology and Taxonomy Section.
N. D. Yan.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 5, p 621-626, May, 1983. 4 Fig, 3 Tab, 19 Ref.

Descriptors: *Hydrogen ion concentration, *Acid lakes, *Transparency, *Thermal regime, Neutralization, Chlorophyll, Phytoplankton, Phosphorus, Epilimnion, Hypolimnion, Solar heating, Lohi Lake, Ontario.

Prior to experimental neutralization in the fall of 1973, the pH of Lohi Lake was 4.4. The pH was maintained at >6.0 by further small additions of base in 1974 and 1975, but it subsequently declined, reaching 4.74 by 1979. Secchi transparency (depth) averaged over the ice-free season in Lohi Lake varied from 5.6 to 9.3 m. Secchi depth was not correlated with chlorophyll concentrations, phytoplankton biomass or total phosphorus, but it was negatively correlated with pH. Secchi depth was positively correlated with thermocline depth, epilimnetic thickness, and hypolimnetic heating rates suggesting that acidification should result in deeper mixing zones and warmer hypolimnia in lakes. The most probable cause of the increase in hypolimnetic heating rate following re-acidification of the lake is increased direct solar heating of the hypo-

limnetic waters because of increased light penetration. (Moore-IVI)
W84-01974

NUTRIENT LIMITATION IN TWO ARCTIC LAKES, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
G. A. McCoy.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 8, p 1195-1202, August, 1983. 7 Fig, 17 Ref. EPA contract EPA-78-D-X0378.

Descriptors: *Limiting nutrients, *Arctic lakes, *Alaska, Bioassay, Selenastrum, Phosphorus, Nitrogen, Phytoplankton, Standing crop, Dissolved oxygen, Chlorophyta, Primary productivity, Fertilizers.

Batch-culture algal bioassays of Selenastrum capricornutum were used to predict the limiting nutrient in two small arctic-tundra lakes in 1979. In 1980 bioassays were performed again, and fertilizer was added to the lakes to test the predictions made from the 1979 bioassay results. In 1980, after the addition of phosphorus fertilizer, phytoplankton standing crop increased about 10-fold. After the addition of nitrogen fertilizer, another 10-fold increase in phytoplankton growth was measured. Concurrently, maximum daytime dissolved oxygen increased from 100 to 150% saturation, and pH increased from 7.0 to about 9.2. Further additions of fertilizer in late August and early September 1980 caused no significant increase in primary production. If the nitrogen content of the lake water is increased but that of phosphorus is not, no increase in algal growth occurs. Growth increases with phosphorus additions, but the magnitude of this increase is determined by the available nitrogen. When additional nitrogen is supplied to the system, further increases in algal growth occur. When nitrogen and phosphorus are supplied in excess, physical factors such as light or temperature become limiting in the lakes. (Author's abstract)
W84-01977

HYPOLIMNETIC AERATION OF A NATURALLY EUTROPHIC LAKE: PHYSICAL AND CHEMICAL EFFECTS,
British Columbia Ministry of the Environment, Vancouver. Fisheries Research and Technical Services Section.
For primary bibliographic entry see Field 5G.
W84-01978

ORTHOPHOSPHATE TURNOVER TIME IN SHALLOW PRODUCTIVE LAKES,
Alberta Univ., Edmonton. Dept. of Zoology.
E. E. Prepas.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 9, p 1412-1418, 2 Fig, 4 Tab, 21 Ref.

Descriptors: *Orthophosphate, *Productivity, *Lakes, Thermal stratification, Nutrients, Turnover time, Shallow lakes, Canada.

Orthophosphate turnover times were measured in 11 small and medium-sized lakes in western Canada. Turnover times in eight thermally stratified lakes were similar to those of other Canadian lakes: moderately rapid (up to 42 min) in the spring, increasing to very rapid (3-16 min) during July and August. Turnover times in the shallow (i.e. those which mixed intermittently during summer) productive lakes were far more variable, ranging from 17 min to 17 h in spring and 2 min to 36 h during July and August. For individual shallow lakes turnover times remained constant for particular summers. One shallow lake was studied over two summers. In the first summer, turnover times were extremely slow (7-36 h) and in the second summer they were extremely rapid (2-11 min). Therefore the mechanisms controlling nutrient limitation in shallow productive lakes are not constant, and can vary dramatically from year to year. (Author's abstract)
W84-01979

TROPHIC STATE CLASSIFICATION OF LAKES WITH AQUATIC MACROPHYTES,
Florida Univ., Gainesville. Center for Aquatic Weeds.
D. E. Canfield, Jr., K. A. Langeland, M. J. Maceina, W. T. Haller, and J. V. Shireman.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 10, p 1713-1718, October, 1983. 5 Tab, 33 Ref. Dept. of Agriculture cooperative agreement 58-7B30-0-177.

Descriptors: *Aquatic plants, *Macrophytes, *Phosphorus, *Trophic state, Nutrients, Lakes, Florida.

Conventional criteria for classifying trophic state emphasize conditions in the open water and ignore the nutrients, plant biomass, and production associated with macrophytes. A method is proposed for determining the potential water column nutrient concentration through adding the nutrients contained in macrophytes to those in the water. During September and October 1981, six Florida lakes with different limnological characteristics were sampled to determine the biomass of submersed aquatic macrophytes. In these lakes, total submersed macrophyte biomass ranged from 18,100 kg dry wt to 2,170,000 kg dry wt. For calculated potential water column phosphorus concentrations, 20-96% of the phosphorus was in the submersed macrophytes and the total water column phosphorus content (WCP) values were 1.2 to 26 times the measured open water concentrations. The effect of these macrophytes on WCP values and therefore on trophic state assessments depends on the amount of macrophytes relative to the total lake volume. Macrophytes have little effect on trophic state assessment when less than 25% of the phosphorus in the water column is associated with macrophytes and the mean macrophtye concentration in the lake is less than 1 g dry wt/cu m. (Moore-IVI)
W84-01981

HYDROGEOCHEMISTRY OF LAKE TURKANA, KENYA: MASS BALANCE AND MINERAL REACTIONS IN AN ALKALINE LAKE,
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
R. F. Yuretich, and T. E. Cerling.
Geochimica et Cosmochimica Acta, Vol. 47, No. 6, p 1099-1109, June, 1983. 7 Fig, 5 Tab, 42 Ref.

Descriptors: *Geochemistry, *Mass balance, *Minerals, *Lake Turkana, Kenya, Interstitial water, Chemical reactions, Chloride, Sodium, Cation exchange, Calcium, Alkalinity, Sediments, Silicates, Alkaline lakes, Chemical precipitation.

Lake Turkana, in northwestern Kenya, is a closed-basin, alkaline (pH = 9.2) lake of moderate salinity (TDS = 2500 ppm). Principal ions are Na(+), HCO3(-) and Cl(-). The lake is essentially polymictic in the northern basin and little compositional variation occurs in surface water. The Omo River is the principal influent, providing some 80-90% of water input to the lake. Chloride has an apparent accumulation time of about 2500 years after accounting for burial of interstitial water. The bottom sediments are predominantly detrital and fine-grained, yet mineral-water reactions are very important for the geochemical budget. Ca(2+) is precipitated as calcite; Na(+) is removed as an exchangeable cation on smectite; Mg(2+) is probably incorporated into a Mg-silicate phase, most likely poorly-crystalline smectite, as it enters the lake water; K(+) may be used in illite regradation. Cation exchange is a very important process in the mass balance of this lake. Over 40% of incoming Na is removed as an exchangeable cation. After cation exchange and interstitial water burial, Na has a response time of 2650 years, which compares favorably with that of chloride. These processes seem to occur rapidly within the water mass of the lake; other reactions may be important in regulating interstitial water compositions. Several changes occur in the upper 3m of sediment: interstitial-water pH drops to 8.3 and alkalinity increases slightly with depth, SO4(2-) decreases slightly, and amorphous silica saturation is approached. These changes are a response to organic matter oxidation and the dissolution of unstable silicates rather than a reversal of reactions occurring in the lake water: High rates of sedimentation (up to 1 cm per year) may minimize the effects of diffusion between the interstitial waters and the lake water, although burial of interstitial water assumes considerable importance. (Author's abstract)
W84-01985

COMPARISON OF THE FORMULATION FOR EDDY DIFFUSION IN TWO ONE-DIMENSIONAL STRATIFICATION MODELS,
Salford Univ. (England). Dept. of Civil Engineering.
B. Henderson-Sellers, M. J. McCormick, and D. Scavia.
Applied Mathematical Modelling, Vol. 7, No. 3, p 212-215, June, 1983. 1 Fig, 24 Ref. DOE contract DE-AC02-79EV10005.

Descriptors: *Thermal stratification, *Eddy diffusion, *Mathematical models, Lakes, Wind, Water circulation, Water depth.

Models for thermal stratification based on turbulent diffusion concepts by Henderson-Sellers (J. Limnol. Soc. sth. Afr. 1980, 6, 49); and by McCormick and Scavia (Water Resour. Res. 1981, 17, 305), are shown to be equivalent at large values of the Richardson number, Rj. At small Rj, the simpler model reverts to specification of the turbulent diffusion as a constant value. This simplification is also demonstrated to be a realistic approximation only at low wind speeds and for deep lakes. By comparison of these model types, a parameter B (previously empirically defined by McCormick and Scavia) is related conceptually to the lake depth, H. Both model types have been used with success in lake stratification simulations. The equivalence of the parameterizations for the eddy diffusion coefficient has been shown under the constraints of constant current shear, high Richardson number, and low wind speed. The differences lie in the treatment of areas of low diffusion rates: the Henderson-Sellers model uses the turbulent diffusion coefficient at all depths, whereas the other model specifies a critical depth below which the value of K is taken as the thermocline minimum. (Moore-IVI)
W84-01995

ANAEROBIC OXALATE DEGRADATION: WIDESPREAD NATURAL OCCURRENCE IN AQUATIC SEDIMENTS,
Geological Survey, Menlo Park, CA. Water Resources Div.
R. L. Smith, and R. S. Oremland.
Applied and Environmental Microbiology, Vol. 46, No. 1, p 106-113, July, 1983. 4 Fig, 3 Tab, 27 Ref.

Descriptors: *Oxalate, *Sediments, *Decomposition, Anaerobic conditions, Lake sediments, Mud flats, Salt marshes, Aquatic environments, Detritus, Saline lakes, Searsville Lake, Lake Tahoe, South San Francisco Bay, California, Big Soda Lake, Nevada.

Significant concentrations of oxalate (dissolved plus particulate) were present in sediments taken from a diversity of aquatic environments, ranging from 0.1 to 0.7 mmol/liter of sediment. These included pelagic and littoral sediments from two freshwater lakes (Searsville Lake, Calif., and Lake Tahoe, Calif.) a hypersaline meromictic, alkaline lake (Big Soda Lake, Nev.), and a South San Francisco Bay mud flat and salt marsh. The oxalate concentration of several plant species which are potential detrital inputs to these aquatic sediments ranged from 0.1 to 5.0% (wt/wt). In experiments with litter bags, the oxalate content of Myriophyllum sp. samples buried in freshwater littoral sediments decreased to 7% of the original value in 175 days. This suggests that plant detritus is a potential source of the oxalate within these sediments. (C-14)oxalic acid was anerobically degraded to (C-14)CO2 in all sediment types tested, with higher rates evident in littoral sediments than in the pelagic sediments of the lakes studied. The turnover time of the added (C-14)oxalate was less than 1 day in Searsville Lake littoral sediments.

The total sediment oxalate concentration did not vary significantly between littoral and pelagic sediments and therefore did not appear to be controlling the rate of oxalate degradation. However, depth profiles of (C-14)oxalate mineralization and dissolved oxalate concentration were closely correlated in freshwater littoral sediments; both were greatest in the surface sediments (0 to 5 cm) and decreased with depth. The dissolved oxalate concentration (9.1 micromol/liter of sediment) was only 3% of the total extractable oxalate (277 micromol/liter of sediment) at the sediment surface. These results suggest that anaerobic oxalate degradation is a widespread phenomenon in aquatic sediments and may be limited by the dissolved oxalate concentration within these sediments. (Author's abstract)
W84-02051

SENSITIVITY OF AN OLIGOTROPHIC LAKE PLANKTONIC BACTERIAL COMMUNITY TO OXYGEN STRESS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. T. Mikell, Jr., B. C. Parker, and G. M. Simmons, Jr.
Applied and Environmental Microbiology, Vol. 46, No. 3, p 545-548, September, 1983. 4 Tab, 13 Ref. NSF grant DPP-12988.

Descriptors: *Dissolved oxygen, *Supersaturation, *Bacteria, Plankton, Oligotrophic lakes, Antarctic, Growth, Metabolism, Superoxide dismutase, Catalase, Mountain Lake, Giles County, Virginia.

Among the relatively few known natural aquatic environments in which prolonged or permanent high dissolved oxygen (HDO) conditions occur are certain oligotrophic, perennially ice-covered lakes in dry valleys of southern Victoria Land, Antarctica. To develop techniques for studying those Antarctic lakes and to obtain base-line data for comparison, an investigation was undertaken of the planktonic microbial community in Mountain Lake, Giles County, Virginia during the summer of 1982. Dissolved oxygen at approximately four times normal saturation (42 mg/l) inhibited the growth and metabolism of summer planktonic bacteria in the surface water of alpine oligotrophic Mountain Lake. Data were derived from growth of CFU on membrane filters, C-14 labeled D-glucose incorporation into the extractable lipid of these CFU, and respiration and assimilation of labeled D-glucose by lake water samples. Statistically significant (alpha < 0.05) differences were not detected in either CFU or C-14 incorporation in lipid when superoxide dismutase (30 U/ml) or catalase (130 U/ml) was added to the medium. Thus, exogenous oxygen by-products apparently are not responsible for the observed inhibition of growth and metabolism. (Moore-IVI)
W84-02057

2I. Water In Plants

WATER BUDGET OF AN EASTERN DECIDUOUS FOREST STAND,
Oak Ridge National Lab., TN. Environmental Sciences Div.
R. J. Luxmoore.
Soil Science Society of America Journal, Vol. 47, No. 4, p 785-791, July-August, 1983. 6 Fig, 1 Tab, 21 Ref. DOE contract W-7405-eng-26.

Descriptors: *Soil water, *Soil water potential, *Water budget, *Forests, Hydraulic gradient, Seasonal variation, Simulation, Mathematical models, Evapotranspiration, Root zone.

Soil water content and soil matric potential were monitored during 2 years at two neighboring ridge-top sites in an oak-hickory stand on a Typic Paleudult forest soil with cherty silt loam texture. Hydraulic gradients and soil water contents showed distinct seasonal variation. Soil water dynamics and water budgets were simulated with a soil-plant-atmosphere water flow model using meteorologic, soil, and plant characteristics estimated for the two sites. A seasonal pattern of soil water drainage and upward fluxes was predicted by the model that corresponded with the field-determined hydraulic gradients. Recharge of water up into the root zone (0- to 90-cm depth) from lower depths was predicted to contribute an average of 9 and 29% of the soil evaporation plus transpiration water loss at the two sites. Total evapotranspiration, including interception evaporation, was similar at the two sites; however, the greater upward water flux at one site compensated for the lower soil water capacity in the root zone at that site. There were significant differences between calculated and simulated daily drainage rates. Simulated soil water contents for the two study sites differed somewhat from measured values obtained on specific days. At longer time scales, the annual water budgets simulated for the sites were similar and were in reasonable agreement with measurements from a local watershed study. Annual evapotranspiration was predicted to be 74.5 cm for the ridge-top forest stand, somewhat higher than the average of 70.5 cm estimated for the whole watershed. (Author's abstract)
W84-01871

2J. Erosion and Sedimentation

EARLY EUTROPHICATION IN THE LOWER GREAT LAKES: NEW EVIDENCE FROM BIOGENIC SILICA IN SEDIMENTS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 2H.
W84-01840

RELATIVE ERODIBILITY OF 20 CALIFORNIA RANGE AND FOREST SOILS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
K. E. Trott, and M. J. Singer.
Soil Science Society of America Journal, Vol. 47, No. 4, p 753-759, July-August, 1983. 2 Fig, 6 Tab, 42 Ref.

Descriptors: *Soil erosion, *Erodibility, Mineralogy, Clays, Soil texture, Mathematical models, Universal Soil Loss Equation, California.

The Universal Soil Loss Equation's K nomograph may not account for all of the factors affecting erodibility of western upland soils. To further investigate this, laboratory rainfall simulation on 0.6- by 0.6-m plots of sieved soil at 9% slope was used to measure relative erodibility of 20 upland soils, including two soils from terraces of the Sacramento River. The most powerful predictor in a stepwise multiple regression of erodibility, on a mass basis, was a combined smectite plus vermiculite clay mineralogy term. Also included in the four-variable regression equation were bulk density, pyrophosphate-extractable Fe + Al, and the standard texture term M. R(2) for the equation was 0.800. Smectite plus vermiculite, M, a clay mineralogy-pyrophosphate Fe + Al interaction term, pH, organic matter, oxalate Fe + Al, and vermiculite were the seven significant terms in the equation predicting soil loss on a volume basis. This equation had an R(2) of 0.772. For now, the best available tool for predicting erodibilities of western upland soils appears to be the Universal Soil Loss Equation erodibilities nomograph. Because of the large differences in parent materials and soil-forming conditions that distinguish midwestern from western soils, consideration of soil mineralogy in future predictive work may improve the predictive capacity of the nomograph. There may be value in examining direct and indirect indicators of soil parent material and soil development with regard to predicting erodibility. (Moore-IVI)
W84-01867

MATHEMATICAL MODEL OF SOIL EROSION AND DEPOSITION PROCESSES: I. THEORY FOR A PLANE LAND ELEMENT,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
C. W. Rose, J. R. Williams, G. C. Sander, and D. A. Barry.
Soil Science Society of America Journal, Vol. 47, No. 5, p 991-995, September-October, 1983. 1 Fig, 17 Ref.

Descriptors: *Soil erosion, *Soil deposition, Mathematical models, Kinematic flow, Sedimentation, Rainfall detachment, Soil entrainment, Overland flow, Slope, Runoff.

A new mathematical model of soil erosion and deposition on a plane land element makes use of an approximate analytic theory of runoff on a plane assuming kinematic flow. Plane land elements are important landscape elements in both farmed and natural systems. Rates of the following simultaneously occurring erosion/deposition processes are represented mathematically: rainfall detachment, sediment deposition, and soil entrainment by overland flow. The concept of stream power is used in representing the entrainment process. The form of analysis reduces the first-order partial differential equation expressing conservation of mass of sediment to an ordinary differential equation, which can thus be solved analytically. This solution gives sediment concentration at any time as a function of distance down the plane in terms of four defined soil factors, the slope of the land, two separate cover factors, and the rainfall and runoff rates. The product of water flux and sediment concentration gives sediment flux at any time and position on the plane. (Moore-IVI)
W84-01874

MATHEMATICAL MODEL OF SOIL EROSION AND DEPOSITION PROCESSES: II. APPLICATION TO DATA FROM AN ARID-ZONE CATCHMENT,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
C. W. Rose, J. R. Williams, G. C. Sander, and D. A. Barry.
Soil Science Society of America Journal, Vol. 47, No. 5, p 996-999, September-October, 1983. 5 Fig, 2 Tab, 10 Ref.

Descriptors: *Soil erosion, *Soil deposition, *Arid lands, Runoff, Sediment concentration, Mathematical models, Sediment entrainment, Soil detachment, Overland flow, Arizona.

Mathematical theory for soil erosion and deposition processes on a plane land element was applied to data on runoff and sediment concentration as a function of time for nine runoff events from a small (1.3 ha) arid watershed in Arizona. Sediment concentration (and therefore sediment flux) vs. time measured at the exit to the watershed could be matched by the theory using particular values of two physically defined parameters. These two parameters are essentially the detachability of soil to rainfall, and the efficiency of sediment entrainment by overland flow. The first parameter had greatest effects on sediment concentration early in any runoff event, and the second parameter dominated later concentrations, thus allowing almost independent assessment of both parameters. The variation in soil detachability with mean depth of overland flow derived from the field data bore similarities to controlled laboratory observations. (Author's abstract)
W84-01875

EFFECT OF CROP RESIDUE, TILLAGE-INDUCED ROUGHNESS, AND RUNOFF VELOCITY ON SIZE DISTRIBUTION OF ERODED SOIL AGGREGATES,
N. P. Cogo, W. C. Moldenhauer, and G. R. Foster.
Soil Science Society of America Journal, Vol. 47, No. 5, p 1005-1008, September-October, 1983. 5 Fig, 16 Ref.

Descriptors: *Soil erosion, *Soil aggregates, *Tillage, *Crop residues, *Velocity, Plowing, Flow rate, Sediment transport, Conservation tillage, Roughness.

The percentages of eroded soil aggregates over 10 size classes ranging from 0.002 to 2.0 mm in diameter as affected by crop residue cover, tillage-induced roughness, and water flow velocity were investigated under field conditions using simulated rainfall. The soils used were a 4.5% slope Russell silt loam and a 6.5% slope Martinsville loam. With no vegetation present, the smallest eroded aggre-

gates came from a chisel-plowed surface while the largest came from chisel- and moldboard-plowed surfaces which had been disked. A no-till treatment gave intermediate values. The D50 size (the aggregate size which 50% of the aggregates exceed) in the absence of soil cover was 0.033, 0.032, 0.020, and 0.011 mm for chisel plow plus disk, moldboard plow plus disk, no-till and chisel plow, respectively. When soil was covered by residue, and size distribution of the eroded aggregates was not greatly different among the tillage treatments. The D50 size was reduced in this case to about 0.012 mm for all tillage systems. For no-till, the percentage of the eroded aggregates > 0.05 mm decreased exponentially (r^2 = 0.85) with an increase in residue cover. Under chisel plowing residue was not effective in reducing the quantity of larger aggregates in the runoff. An increase in flow rate caused an increase in water flow velocity which, in turn, caused a linear (r^2 = 0.94) increase in the percentage of the eroded aggregates > 0.05 mm, for chisel plowing. The results from this study were explained in terms of sediment trapping capacity of the soil surface, as well as runoff transport capacity. (Author's abstract)
W84-01877

CHARACTERISTIC PARAMETERS OF NONEQUILIBRIUM PROCESSES IN ALLUVIAL CHANNELS OF FINITE LENGTH,
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
W. F. Jaramillo, and S. C. Jain.
Water Resources Research, Vol. 19, No. 4, p 952-958, August, 1983. 8 Fig, 25 Ref.

Descriptors: *Sediment transport, *Alluvial channels, Sedimentation, Model studies, Aggradation, Degradation.

An analytical solution for the characteristic parameters of the nonequilibrium processes of aggradation due to sediment augmentation and degradation due to sediment diminution in alluvial channels of finite length is presented. The analytical solution for small time agrees with that for a semiinfinite channel. The analytical solution is compared with the available experimental data. Aggradation and degradation processes are similar to each other and their characteristic parameters are governed by the same equations. The analytical solution for small time is identical to that for a semi-infinite reach. The latter may be considered as a special case of the more general solution presented. The deviation of the experimental data from the analytical results is due to the two simplifications introduced in the model. The experimental results agree with the analytical results for moderate values of sediment overloading. (Baker-IVI)
W84-01888

SEDIMENT DEPOSITION ESTIMATION FROM CESIUM-137 MEASUREMENTS,
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Engineering.
J. K. Mitchell, S. Mostaghimi, D. S. Freeny, and J. R. McHenry.
Water Resources Bulletin, Vol. 19, No. 4, p 549-555, August, 1983. 4 Fig, 5 Tab, 9 Ref.

Descriptors: *Soil erosion, *Sedimentation, Watershed management, Waterway vegetation, Buffers, Soil conservation, Sediment deposition, Water depth, Allerton watershed, 4-H Memorial Lake, Illinois.

The movement of fallout Cs-137 carried by soil particles was studied as an indicator of erosion and sedimentation in the Allerton watersheds and 4-H Memorial Lake located near Monticello, Illinois. Sediment deposition was greater in the waterway draining from watershed IB than in the waterway from watershed IA. At the average rate of 2.3 cm/yr of sediment deposition in the lake (from 1954 to 1979), there will be a loss of over 2 m of water depth in the next century. However, there appears to be a decreasing rate of sediment deposition in the 4-H Memorial Lake as a result of improved conservation practices on the watersheds and the increased effectiveness of vegetated waterways and buffers for retaining sediment. (Author's abstract)
W84-01938

PREDICTING EROSION AND DEPOSITION ON A STRIPMINED AND RECLAIMED AREA,
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
R. M. Khanbilvardi, A. S. Rogowski, and A. C. Miller.
Water Resources Bulletin, Vol. 19, No. 4, p 585-593, August, 1983. 12 Fig, 1 Tab, 16 Ref. EPA-ARS Interagency Agreement grant EPA-IAG-D5-E763.

Descriptors: *Stripmines, *Soil erosion, *Land reclamation, Sediment deposition, Mathematical models, Rill erosion, Interrill erosion, Spatial distribution, Sediment transport, Pennsylvania.

A rill-interrill erosion model was applied to a mined and reclaimed area. Soil loss from the interrill areas was estimated by the Universal Soil Loss Equation (USLE). The model considers the fate and ultimate disposition of the sediment from interrill areas along with the fate and destination of soil materials detached by the rill flow. The net sediment loss was predicted by comparing, for a given flow, the amounts of eroded soil to rill transport capacity. The experimental area was a small reclaimed site in Central Pennsylvania. The model was used to analyze the distribution of comulative soil loss for five storm events, which occurred in the summer of 1981. The output consisted of a map showing erosion or deposition on each 10 x 10 ft subarea at the experimental site. The significant advantage of the model was its ability to predict areal distribution of erosion and deposition. On the average, the predicted results differed from measure erosion and deposition at a point by 25%. Although developed for stripmined and reclaimed areas, the model could be applied to predict erosion and deposition on agricultural watersheds as well as urban watersheds. (Moore-IVI)
W84-01944

2K. Chemical Processes

BRACKISH-WATER AQUACULTURE IN PYRITE-BEARING TROPICAL SOILS,
Lamont-Doherty Geological Observatory, Palisades, NY.
H. J. Simpson, H. W. Ducklow, B. Deck, and H. J. Cook.
Aquaculture, Vol. 34, No. 3/4, August, 1983. 5 Fig, 5 Tab, 26 Ref.

Descriptors: *Pyrite, *Aquaculture, *Leaching, Tropical regions, Brackish water, Acidity, Oxidation, Iron, Sulfur, Southeast Asia, Malaysia.

Oxidation of pyrite in soils and sediments of coastal areas yields large amounts of acid, as well as soluble iron and aluminum, which seriously reduce yields of aquaculture organisms. Potential for this problem is widespread in tropical and subtropical areas, especially for brackish-water aquaculture in Southeast Asia. Data on water, sediment and soil chemistry at a new aquaculture facility in peninsular Malaysia are reported to document environmental conditions during the initial years of operation when the yields of food organisms are low. Estimated rates of leaching of acid from the pyrite-bearing dike soils suggest that acidity problems will probably persist at this facility for a number of years. Ways to minimize the problems include the fact that extensive soil survey work should be performed prior to site selection and construction of aquaculture facilities. Dike system design should be such that it will minimize soils exposed to the atmosphere. Serious planning as to the acid sensitivity of the potential culture organisms should be made. Systematic collection of water quality data related to acidity impacts should be made on a routine basis to monitor rate and pattern of removal of acidity from the system. (Baker-IVI)
W84-01834

PHOSPHORUS AND CALCIUM CARBONATE SOLUBILITIES IN LAKE KINNERET,
Technion - Israel Inst. of Tech., Haifa.
For primary bibliographic entry see Field 2H.
W84-01836

DEVELOPMENT OF REACTION MODELS FOR GROUND-WATER SYSTEMS,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2F.
W84-01984

HYDROGEOCHEMISTRY OF LAKE TURKANA, KENYA: MASS BALANCE AND MINERAL REACTIONS IN AN ALKALINE LAKE,
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
For primary bibliographic entry see Field 2H.
W84-01985

NUMERICAL EXAMINATION OF THE ELUTION OF AQUATIC SEDIMENTS (RECHNERISCHE BEHANDLUNG DER ELUTION VON SEDIMENTEN),
Technische Hochschule, Darmstadt (Germany, F.R.). Inst. fuer Wasserversorgung, Abwasserbeseitigung und Raumplanung.
H. Schreiner.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 3, p 96-107, 1983. 9 Fig, 3 Tab, 20 Ref.

Descriptors: *Sediments, *Elution, Lake sediments, Oxidation, Diffusion, Ammonium, Water quality.

In slowly running waters or lake bottoms, sediments are formed. Permanent interactions exist between these sediments and the fresh water. The mechanisms of these exchanges are consolidation, diffusion and convection of gas. The processes affect the quality of the sediment and of the overlying water. The concentration of the most reduced substances in the sediment is more intensive than in the body of water. Therefore the interactions between sediments and water lead to a slow elution of the sediments. More than that, the sediment usually has a high demand of oxidizing agents. The elution of aquatic sediments was examined in laboratory scale experiments and generally described by the principals of diffusion. An example of ammonium as verification of experimental results is performed. (Author's abstract)
W84-02068

COMMON COMPOSITION CHARACTERISTICS OF FLUORIDE BEARING GROUNDWATERS,
Andhra Univ., Waltair (India). Dept. of Geophysics.
For primary bibliographic entry see Field 2F.
W84-02124

2L. Estuaries

SEDIMENTATION, ACCRETION, AND SUBSIDENCE IN MARSHES OF BARATARIA BASIN, LOUISIANA,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
R. S. Hatton, R. D. DeLaune, and W. H. Patrick, Jr.
Limnology and Oceanography, Vol. 28, No. 3, p 494-502, May, 1983. 5 Fig, 3 Tab, 29 Ref.

Descriptors: *Marshes, *Sedimentation, *Accretion, Brackish water, Salt marshes, Louisiana, Barataria Basin.

Vertical accretion and sediment accumulation rates were determined from the distribution of Cs-137 in cores collected from freshwater, intermediate, brackish, and salt marshes in the Barataria Basin, Louisiana. Vertical accretion rates vary from about 1.3 cm/yr in levee areas to 0.7 in backmarshes. Mineral sediment content of the marsh soil profile decreased with distance from the coast. However, vertical accretion rates were about equivalent in areas of the same type. Autochthonous organic

matter appears to be an important factor defining the process and rate of vertical accretion, especially in the freshwater marshes. Except in natural levee areas, march accretion rates are less than subsidence measured by water level data; however this alone cannot account for observed land-loss patterns in the basin area. Management practices such as burning and channelization with salt water intrusion, which may retard the production and accumulation of organic matter, have serious consequences for marsh accretion and land loss. (Baker-IVI)
W84-01835

SAVING OUR NATION'S WETLANDS,
Committee on Environment and Public Works (U.S. Senate).
J. H. Chafee.
EPA Journal, No. 2, p 3-4, October, 1983. 1 Fig.

Descriptors: *Wetlands, *Water resources development, Environmental effects, Recreation, Fish populations, Habitats.

The need to conserve wetlands has never been more critical than it is today. At present, the modification and the destruction of wetland habitat is the single most important factor affecting migratory waterfowl abundance. Wetlands also contribute to the production of a rich commercial and recreational fishery harvest. They also provide recreational activities other than fishing. Wetlands serve as natural wastewater treatment plants. They prolong and moderate runoff after heavy precipitation or snowmelt. They also aid in well recharge by acting as natural sponges. (Baker-IVI)
W84-01999

ANAEROBIC OXALATE DEGRADATION: WIDESPREAD NATURAL OCCURRENCE IN AQUATIC SEDIMENTS,
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W84-02051

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

EXERGETIC EFFICIENCY OF MSF PROCESS AND THE CONDITIONS OF DESALINATION BY WASTE HEAT,
Tianjin Univ. (China). Dept. of Chemical Engineering.
W. Shi-chang.
Desalination, Vol. 44, p 39-49, 1983. 2 Tab, 4 Ref.

Descriptors: *Desalination plants, *Thermodynamic efficiency, *Exergenetic efficiency, Brine recirculation, Cooling water.

The exergy losses and thermodynamic efficiency of MSF plants with brine recirculation are discussed by means of temperature difference (TD) functions. In a MSF plant, the irreversible losses are found mainly in irreversible heat-transfer and flash evaporation processes. The basic variables are the temperature drop from stage to stage, and the temperature differences between flashed vapor and cooling water. The flash temperature difference function, the heat transfer TD function, and the total TD function are suggested. The proposed TD functions of MSF plants provides a convenient tool to analyze the irreversible behavior and evaluate the exergetic efficiency of this system, because without such improvement the calculation of the exergetic efficiency of a MSF plant according to the classical formula will be not only inconvenient but also insignificant. As a result of present analysis, the reasonable parameters based on the energy consumption are easily chosen. The principles are confirmed by study of typical commercial plants in Hong Kong and Shuwaikh, Kuwait, and a pilot plant in Tianjin, China. The key to saving energy in commercial plants is to make a great effort to reduce the irreversible losses. (Moore-IVI)
W84-02023

SEAWATER VS. BRACKISH WATER DESALTING: TECHNOLOGY, OPERATING PROBLEMS AND OVERALL ECONOMICS,
Mekoroth Water Co., Tel Aviv (Israel).
P. Glueckstern, and Y. Kantor.
Desalination, Vol. 44, p 51-60, 1983. 3 Fig, 2 Tab, 7 Ref.

Descriptors: *Desalination, *Seawater, *Brackish water, Reverse osmosis, Membrane processes, Drinking water, Water quaility, Costs, Energy.

Current operation of seawater and brackish water desalting plants is reported and analyzed regarding operating problems and costs. When properly maintained, desalting plants can be considered reliable sources for augmentation of water supply and water quality improvement. Current actual operation costs emphasize the great difference in cost between desalting brackish water by membrane processes and desalting seawater by thermal processes. Quality improvements of drinking water can be very simple and relatively inexpensive. Recent developments in reverse osmosis technology have made brackish water desalting competitive in many cases with conventional water supply. The potential for further development of seawater desalting is still quite large and its realization in due time is very important in order to avoid prohibitive costs for many applications, especially for those with prevailing or projected high energy costs. (Moore-IVI)
W84-02024

ONE YEAR OF OPERATION OF ISRAEL DESALINATION ENGINEERING'S MULTI-EFFECT DISTILLATION U.S. VIRGIN ISLANDS,
Israel Desalination Engineering Ltd., Tel-Aviv.
U. Fisher.
Desalination, Vol. 44, p 73-84, 1983. 6 Fig, 2 Ref.

Descriptors: *Desalination plants, *Multi-effect distillation, Drinking water, Virgin Islands, St. Thomas, St. Croix, Scaling.

Three MED (multi-effect distillation) plants for 1.25 MGD were installed in St. Thomas and St. Croix by Israel Desalination Engineering. The Low Temperature MED plants made of horizontal aluminum tubes exceeded the acceptance criteria and continuously supply drinking water to the islands with purity of 16 ppm TDS. Since late 1981 the availability has exceeded 97% and the performance ratio is 12.4 or better. Annual average production was 1.3, 1.3 and 1.27 MGD. The most notable advantages of the MED plants are: the easy start up and operation of the MED process and short period between start up and full capacity; Specific Power Consumption does not change markedly when operating on partial load; low temperature operation results in nearly scale free plant and allows for the use of less expensive construction materials. (Author's abstract)
W84-02025

CAPACITY ADAPTION OF REVERSE OSMOSIS SYSTEMS BY TEMPERATURE AND PRESSURE CONTROL OF THE RAW WATER,
Deutsche Babcock A.G., Krefeld (Germany, F.R.).
K. Heybach.
Desalination, Vol. 44, p 85-90, 1983. 3 Fig, 1 Ref.

Descriptors: *Desalination, *Reverse osmosis, Pressure, Temperature effects, Water treatment.

Permasep Permeator Systems have a permeate capacity variation of nearly three percent for every degree centigrade of temperature variation. The idea of using this temperature phenomenon for the adaption of capacity in permeate production as required over the day originated during the planning stage for three plants of nominal 30 cu m/hr capacity including reverse osmosis system for the production of ultra pure water for electronics. The consumption of permeate subsequently treated to ultra pure quality varied between 30 and 100% of the nominal capacity in the course of the day. The general design of a plant producing ultra pure water is described. The clear and simple relationship between temperature, pressure and feed water, permeate and concentrate flow rates would allow control by microprocessor system and automatically operating valves. This means that there is indeed a capacity adaption for reverse osmosis systems. (Baker-IVI)
W84-02026

DESALTING WATER COSTS USING WASTE HEAT FROM POWER SYSTEMS COMBINED WITH THE VTFE AND VAPOR COMPRESSION,
Ebasco Services, Inc., New York.
S. J. Senatore.
Desalination, Vol. 44, p 129-135, 1983. 2 Fig, 1 Tab, 1 Ref.

Descriptors: *Desalination, *Reverse osmosis, *Multistage flash evaporator, *Vertical tube foaming evaporator, Costs, Energy, Powerplants, Key West, Florida.

An updated desalted water cost comparison is presented for the reverse osmosis (RO), multistage flash evaporator (MSF) and the high efficiency performance vapor compression vertical tube foaming flow evaporator (VCVTFE). The capital costs of the VCVTFE plant is based on a realistic conceptual design for a 2.5 mgd single purpose plant. Together with the vapor compression cycle, high performance ratios of about 35 lbs. product per 1000 Btus can be readily achieved. These high efficiency concepts and use of waste heat are economical with current day high fuel costs. Projected bottom line water costs show that the VCVTFE process is more economical than RO, which is cheaper than MSF desalting costs at today's high energy costs. Power plant turbine exhaust steam normally rejected to the ocean through seawater-cooled condensers, can be used to produce distilled water with an efficient vertical tube foaming flow (VTFE) evaporative condenser. This waste heat VTFE plant was designed to provide 150 cu m per day of distillate having about 5 ppm of total dissolved salts, for use of boiler feed at a 37 MWe coastal power plant at Key West, Florida. The energy cost of the VCVTFE process is only 51% of the energy cost of the RO process. (Moore-IVI)
W84-02027

SEAWATER DESALINATION WITH VERY LOW ENERGY CONSUMPTION,
Bavaria Anlagenbau G.m.b.H., Fuerstenfeldbruck (Germany, F.R.).
L. Cavalieri, and G. Nasser.
Desalination, Vol. 44, p 143-151, 1983. 5 Fig, 3 Tab.

Descriptors: *Desalination apparatus, *Multiple effect process, *Heat exchangers, Vertical tube evaporation, Multi-stage flash evaporation, Corrosion resistance, Scaling, Seawater, Bavaria.

Based on a new plate heat exchanger design, a large scale prototype desalination plant, operating as multiple effect process (vertical tube evaporation (VTE) and multi-stage flash (MSF) process) has been erected in Bavaria. Compact completely welded titanium plate heat exchangers allows the vertical arrangement of 55 stages within a pressure box of 34 m height, 2.5 x 3.2 m ground area, generating a fresh water output of 5000 cu m/day with a Performance Ratio of $>$ 40 (tons of fresh water per ton of supplied steam). A 55 stage VTE evaporator section is combined with a 75 stage MSF section, operating from 130 C down to 30-35 C for maximized steam economy. All heat exchangers are manufactured of titanium while all internal box surfaces in contact with seawater are made of monit, for corrosion resistance. Scaling is minimized as brine is passed once through the plant, and operation with reduced pH values presents no corrosion danger. A large pressure number is feasible in view of the compact heat

exchanger design and the stage interconnecting internal baffle system which avoids external pipework, and due to the automation of the plate heat exchanger manufacturing methods. (Moore-IVI)
W84-02028

SQUEEZING DESALTED WATER COSTS BY PROPER CHOICE OF THE DESALTING TECHNOLOGY AND WATER MANAGEMENT,
National Research Centre, Cairo (Egypt). Pilot Plant Lab.
A. M. Abulnour, M. H. Sorour, F. A. Hammouda, and A. M. Abdel Dayem.
Desalination, Vol. 44, p 189-198, 1983. 3 Fig, 2 Tab, 2 Ref.

Descriptors: *Desalination, *Water reuse, *Costs, Developing countries, Water management, Energy, Water conservation, Social aspects, Egypt.

Due to water shortages in many areas in Egypt, the wider utilization of desalination techniques is certain, but problems may be encountered due to the improper selection of the technological package, or conditions of the site itself. Guidelines for proper selection of the desalting technology are presented which may apply to similar developing countries. Factors which should be considered include: the socio-cultural setting of the community, technical skills in the community, conservation and water management practices, fuel prices, and the importance of incorporating waste disposal and reuse in the same package. The availability of reliable and cheap energy sources may be the most dominant criterion for the selection of a desalting technology. Wider utilization of dual desalination-reuse plants seems to be essential in remote seashore and desert communities. Industries that consume large amounts of energy and water should be discouraged until the time when more energy and water are available from cheap sources. (Moore-IVI)
W84-02029

SPECIFIC ENERGY RECOVERY PUMPING SYSTEM FOR REVERSE OSMOSIS DESALINATION,
Pompes Guinard, Annecy (France).
P. Goubeau, and P. Leroy.
Desalination, Vol. 44, p 199-206, 1983. 2 Fig, 2 Tab.

Descriptors: *Desalination, *Pumps, *Reverse osmosis, Seawater, Mechanical equipment.

The main advantages of reverse osmosis, as opposed to thermal processes, are the lower running costs, especially energy consumption, shorter delivery time, and the low temperature process, and all the energy being in the form of pressure. The problem now is to determine the best energy recovery pumping system: the integrated systems are those offering the greatest advantages in terms of cost savings and operating facilities. The integrated TPMDX energy recovery pumping system was designed by Pompes Guinard, which is one of the largest international pump manufacturers. The TPMDX system has the advantages of reliability, costs, flexibility, and short delivery time. (Baker-IVI)
W84-02030

EVALUATION AND DEVELOPMENT OF TECHNICAL THERMOPLASTIC SYSTEMS FOR DESALINATION AND OTHER WATER TREATMENT APPLICATIONS,
General Electric Plastics B.V., Bergen op Zoom (Netherlands).
G. Mossner.
Desalination, Vol. 44, p 325-327, 1983.

Descriptors: *Desalination, *Thermoplastics, Reverse osmosis, Lamella separator, Resins, Water treatment.

Successful applications and revolutionary new concepts for water treatment currently under development are considered, from an industrial point of view. Examples such as AQUANOVA (C.F.E.), GKSS (reverse osmosis), and PASSAVANT (lamella separator) are considered. NORYL resin is discussed as an excellent material possessing a combination of specific properties, virtually unique among engineering plastics. It is a modified polyphenyleneoxide offering a number of high performance properties. It lends itself well to heat treating methods, is corrosion resistant, chemical resistant and has favorable mechanical properties. (Baker-IVI)
W84-02031

OPERATING EXPERIENCE AND PERFORMANCE DATA ON AN ADVANCED BARGE-MOUNTED VTE/VC SEAWATER DESALINATION PLANT,
B. Ohlemann, and D. K. Emmermann.
Desalination, Vol. 45, p 39-47, 1983. 5 Fig, 1 Tab, 5 Ref.

Descriptors: *Desalination plants, *Vapor compression, *Vertical tube foam evaporation, *Multistage flash evaporation, MEDA, Helgoland, West Germany.

The floating desalination demonstration plant MEDA presents an advanced concept to produce fresh water from seawater with low energy consumption. This has been achieved by developing a new desalting system with the combination of vapor compression (VC), vertical tube evaporation with foamy upflow (VTFE) and multi-stage flash evaporation (MSF). MEDA was operated at Helgoland in the North-Sea at its design capacity of 5000 cu m/day and a performance ratio of 22 to 1 kg/kg. The 24 VTE effects evaporator combined with two vapor compression topping effects operated at a maximum feed temperature of 135 C with sulfuric acid pretreatment. High heat transfer rates were obtained using foamy upflow in double-fluted evaporator tubes without inter-effect pumps. Data were obtained for an alternative pretreatment system for feed make-up using a fluidized bed ion exchanger system operating in the countercurrent mode. Calcium ion content in the feedwater was demonstrably reduced by more than 90%. The practical feasibility of advanced desalting technology was sucessfully demonstrated. Performance ratios 2 to 3 times higher than MSF process are achievable. The successful demonstration of MEDA at Helgoland supports the acceptance of VC/VTFE or VTFE for single and dual purpose plants. (Moore-IVI)
W84-02032

FLOATING DESALINATION PLANTS; AN ENGINEERING, OPERATING AND ECONOMIC APPRAISAL,
Water and Electricity Dept., Abu Dhabi (United Arab Emirates).
M. Fadel, K. Wangnick, and N. M. Wade.
Desalination, Vol. 45, p 49-63, 1983. 3 Fig, 3 Tab.

Descriptors: *Desalination plants, *Floating desalination plants, *Costs, Construction costs, Barges, Standby plants, Abu Dhabbi.

The simplest type of floating plant consists of a basic pontoon or barge on which the distiller and auxiliary plant are mounted. The obvious attraction of such plants is that practically all construction can be carried out in the country of manufacture. The concept of a self-propelled seagoing plant introduces a large measure of flexibility into the operation of a floating desalination plant. For the relatively small extra costs of propulsion and navigation equipment, such a vessel can carry out several functions, such as: operation as a standby plant; providing reserve capacity to meet exceptional short term demands; and helping to meet rapidly increasing demand until completion of a land based plant. The first fully seagoing desalination vessel, named RUMAITH, is now in service in Abu Dhabi. This vessel carries two 1250 cu m/day MSF distillers and is complete with power generating plant and full marine and navigation facilities. Shore facilities are being engineered and constructed at three remote sites; Silaa, Sir Baniyas Island and Dalma Island. Facilities at each site include water unloading, water storage and pumping, fuel unloading, and fuel pumping. Excluding the shore facilities, the floating plant is shown to be marginally lower in cost than a comparable land based plant. The addition of shore facilities and permanent fuel and water connections by pipelines and offshore buoys will increase the cost of the floating plant to some 7% above the land based installation. The mobile plant will compete effectively if regarded as a standby plant for a number of independent on-shore sites. (Moore-IVI)
W84-02033

SIMULATION OF M.S.F. DESALINATION PLANTS,
SWCC Al-Khobar Desalination Plant (Saudi Arabia).
A. M. Omar.
Desalination, Vol. 45, p 65-76, 1983. 5 Fig, 4 Tab, 6 Ref.

Descriptors: *Desalination, *Computer models, *Simulation, Salinity, Water temperature, Seawater, Mathematical models, Al-Khobar, Saudi Arabia.

A simulation program for modeling MSF desalination plants can be used to either design or simulate plants in actual operation. The desired relationships for the formulation of a mathematical model consist of standard chemical engineering relationships: material balances, energy balances, momentum balances, kinetic relationships, equilibrium relationships, and control relationships. The mathematical model developed was translated into a Fortran IV computer program SWEDC for the design or simulation of MSF desalination plants with the aid of an IBM 370 computer. The program outputs or results consist of the various calculated process parameters, including condenser surface area of the various plant sections, process pump heads, and basic stream flow rates. Convergence of solution is based upon a thermodynamically feasible solution. Application of the program to desalination plant designs showed excellent results. Application of the simulation mode of the program to Al-Khobar (Phase-I) MSF desalination plant indicates that the original plant production cannot be obtained due to the difference between the actual sea water salinity (56,000 ppm) and that reported by the project consultant (50,000 ppm), and the influence of high summer sea water temperatures (35 C). (Moore-IVI)
W84-02034

COMPARATIVE STUDY BETWEEN VAPOR COMPRESSION AND MULTI EFFECT BOILING DESALINATION SYSTEMS,
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Thermal Engineering.
M. A. Darwish, K. A. Fathalah, and S. E. Aly.
Desalination, Vol. 45, p 77-80, 1983. 4 Fig.

Descriptors: *Desalination, *Vapor compression, *Multi-effect boiling, Thermodynamics, Costs.

The following arrangements are considered: a. multi effect vapor thermocompression (VTC); b. multi effect boiling (MEB); c. a hybrid multi-effect boiling/vapor thermocompression. The variations of the thermodynamic properties of water are computed using special subroutines. Using an ejector to perform the compression of the entrained vapor is considered to be a low efficiency process due to irreversibilities encountered in the entrainment, mixing, and compression process. The advantages of using the ejector is that it acts as a controlling device, influenced by the following parameters: total temperature difference between the hot and cold ends of the plant, concentration ratio of the brine and its effect on the boiling point elevation, number of effects, temperature difference across the condenser evaporator units. Using ejectors over the same total temperature difference would result in a reduction of the number of effects used in a conventional MEB without a proportional reduction in the plant productivity, which would lead to a reduction in the capital and running costs for pumping power. For specific temperature difference, this arrangement could be beneficial for small capacities since a smaller number of effects would require less maintenance and gives more

stable characteristics. The hybrid arrangement would include the advantages of both MEB and VTC. (Moore-IVI)
W84-02035

APPLICATION OF THE MULTI-EFFECT PROCESS AT HIGH TEMPERATURE FOR LARGE SEAWATER DESALINATION PLANTS,
Societe Internationale de Dessalement, Paris (France).
B. Franquelin, F. Murat, and C. Temstet.
Desalination, Vol. 45, p 81-92, 1983. 3 Fig, 2 Tab, 2 Ref.

Descriptors: *Desalination plants, *Multi-effect process, Energy, Costs, Salinity, Water temperature, Seawater, Arabian Gulf.

A large sea water desalination plant, using the multi-effect process at high temperature is described and compared with the other distillation processes. The multi-effect plant is easily adaptable in a wide range of operating conditions. It has a low total energy consumption (8.75 KWh per cu m produced), and a high GOR is obtained (12.4). Compared with a MSF of the same production capacity, the investment costs are smaller. This leads to a substantial decrease in cost of the produced water. The technology of horizontal sprayed tubes is a proven one and has been executed more than a hundred times on small and medium units. The multi-effect plant is applicable whatever the seawater salinity and temperature. This is important in areas such as the Arabian Gulf, where the salinity may be 50 g/kg and the temperature may be 5 C. Separate feed of each cell allows the modulation of the brine salinity, permitting minimization of seawater pretreatment. High purity water can be easily produced even from seawater with high salt content. (Moore-IVI)
W84-02036

COMPUTER SIMULATIONS OF MULTIPLE-EFFECT FFE-VC SYSTEMS FOR WATER DESALINATION,
Lund Inst. of Tech. (Sweden). Dept. of Chemical Engineering.
G. Aly.
Desalination, Vol. 45, p 119-131, 1983. 5 Fig, 4 Tab, 9 Ref.

Descriptors: *Desalination apparatus, *Multiple-effect falling film evaporator, *Vapor compression, Simulation, Energy, Costs.

Different configurations for multiple-effect falling film evaporators (FFE) and vapor compression (VC) systems were simulated. For multiple-effect FFE systems, the number of effects were varied from 6 to 21. For VC systems, different locations of the compressor were studied. A plant with a capacity of 6790 cu m/day (1 MGD) was chosen. Heating surface of evaporators and preheaters, boiling temperature, temperature difference in each effect, tube length and liquid load are process parameters which were investigated. Performance ratios for the multiple-effect FFE configurations seemed to be low, which may be due to the use of smooth tubes in these simulations. The 15 effect configuration had the minimum water cost. For the VC systems, the economy of size is very important in designing a feasible system. Of the three VC configurations, the configuration with the compressor operating across one FFE effect shows a slightly lower unit water cost. For a capacity of 1 MGD, and optimum evaporation area of 4500 sq m, a single stage centrifugal compressor operating with pi = 1.19 and a total energy requirement of 1637 kW will be needed. Sensitivity analyses show that for energy conservation, the highest brine temperature should approach 120 C and the evaporator, with an optimum tube length of 7 m, should be operated at a high liquid load. (Moore-IVI)
W84-02037

OPERATING EXPERIENCE OF DESALINATION UNITS IN SCHEVCHENKO,
Ju. S. Baranov, N. A. Kabluchko, P. K. Lebedev, A. A. Samarkin, and A. P. Egorov.
Desalination, Vol. 45, p 167-174, 1983. 5 Ref.

Descriptors: *Desalination plants, *Shevchenko, USSR, Nuclear powerplants, Seawater, Potable water, Feedwater.

Shevchenko is the only town in the USSR using only artificially prepared potable water, the main component of which is distillate produced from seawater. Desalination units of three types have been built in Schevchenko and operated at the atomic thermoelectric fast reactor plant. Four and five stage concurrent units with natural circulation of solution had a limited number of evaporation stages because of the necessity of ensuring a temperature drop of no less than 10-12 C per stage for normal operation. At start-up, the units are inert, and a long time is needed to produce stable conditions. The 10-stage concurrent unit with forced brine circulation is more economical in heat consumption, and has good stability and smooth operation. The distillate produced can be used to feed steam generators of electric power stations without additional treatment. The 34-stage flash unit is easy to operate, compact and similar to the 10-stage unit in heat consumption. It is very sensitive to environmental disturbances, and the distillate produced is not applicable to feed steam generators. It is not compatible with scale prevention by means of seed crystals. The 34-stage unit has a narrow range of possible output variation, 80-100%. The 10-stage evaporation units have been chosen to extend the Shevchenko desalination complex. They are reliable in operation and give a distillate of 0.5-2.0 mg/l salt content. (Moore-IVI)
W84-02038

RELIABILITY ASSURANCE SURVEY - AN INITIAL STEP TOWARDS INCREASED OPERATING RELIABILITY AT EXISTING DESALINATION FACILITIES,
Kuljian Corp., Melbourne, FL. Desalination Div.
R. E. Bailie.
Desalination, Vol. 45, p 185-194, 1983. 1 Fig, 3 Tab, 7 Ref.

Descriptors: *Desalination plants, *Maintenance, *Computers, *Reliability, Middle-East, Statistical methods, Planning.

Over the next few years a large number of new MSF units will be added to the current installed capacity of desalination facilities in the Middle-East. There will be an ever increasing need to achieve optimum utilization of the maintenance personnel while insuring the operating reliability of these facilities over the long term. The Reliability Assurance Survey offers a step-by-step procedure which utilizes proven reliability engineering methods to initially evaluate and later predict the reliability of all critical subsystems and components within an existing facility. The procedure begins with the collection and analysis of historical data to develop a data base, followed by a computerized manipulation of this data to define the most critical subsystems and components. Systematic methods and statistical techniques are utilized to predict the reliability of these critical subsystems and components. With the aid of a microcomputer system, the data base can be continuously up-dated and the maintenance planning staff can be provided with sufficient information to predict the reliability or failure of all critical subsystems and components. A criticality analysis can focus upon those most critical components which may be candidates for a condition-based maintenance program which would use on-line diagnostics to continuously monitor the condition of the major down-time sources. (Moore-IVI)
W84-02039

PARAMETRIC STUDY ON SEAWATER REVERSE OSMOSIS DESALTING PLANTS,
Bechtel National, Inc., San Francisco, CA. Research and Engineering.
R. Soo-Hoo, L. Awerbuch, S. May, M. Mattson, and S. Kremen.
Desalination, Vol. 46, p 3-15, 1983. 9 Tab, 1 Ref.

Descriptors: *Desalination, *Reverse osmosis, Membrane processes, Seawater, Cost analysis, Automation, Energy recovery, Intakes, Site selection.

A comprehensive parametric technical and economic study of seawater reverse osmosis desalination plants was undertaken. The objective was to derive updated costs for plants ranging from 100,000 gpd to 5 million gpd at a Caribbean site and at a continental US site. The study considered hollow-fiber and spiral-wound membranes in one- and two-pass configurations, various seawater intakes (surface, seawater well, Panney collectors), various high pressure pumping systems (centrifugal, positive displacement), optional energy recovery systems (Pelton wheel, hydroturbines, work-flow exchangers), and operation and maintenance labor requirements. Other variables included in the study were reduced operating pressure, extended membrane life, higher recovery ratio, improved pumping and energy recovery system efficiency, and increased plant automation. To obtain the lowest cost product water in seawater reverse osmosis, one of the key decisions in the RO plant design is the selection of the site and the intake system suitable for the local hydrogeology of that site. Intake selection is important because of its impact on the degree of pretreatment required for proper plant operation and the resulting product water economics. (Baker-IVI)
W84-02077

DESALINATION OF WATER IN SAUDI ARABIA BY REVERSE OSMOSIS, PERFORMANCE STUDY,
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
C. K. Wojcik.
Desalination, Vol. 46, p 17-34, 1983. 6 Fig, 5 Tab, 3 Ref.

Descriptors: *Desalination, *Reverse osmosis, Saudi Arabia, Salbukh, Buwayb, Jeddah, Maintenance, Performance evaluation, Costs, Salinity, Seawater.

The performance of major reverse osmosis plants in Saudi Arabia is reviewed in terms of their actual productions, maintenance problems, water recoveries, quality of products and their cost. The operating experiences with these plants have ranged from marginal to excellent. Most of the problems encountered were related to the following concerns, either singly or in combination: harsh conditions in which these plants had to operate, inadequate pretreatment of water, lack of trained operators, lack of preventive maintenance, as well as designs that did not take into consideration these factors. The plants discussed were at Salbukh, Buwayb, and Jeddah. Whether the process with present membrane technology can be successful in desalination of Saudi Arabia's seawaters still remains an open question. Thus far such experience has been limited to the Red Sea where salinity rarely exceeds 42,000 ppm. (Baker-IVI)
W84-02078

DESALINATION BY REVERSE OSMOSIS IN CHINA,
W. Ying.
Desalination, Vol. 46, p 35-40, 1983. 8 Fig, 1 Ref.

Descriptors: *Desalination, *Reverse osmosis, *China, Water reuse, Water supply development, Membranes.

Research is described concerning desalination by reverse osmosis (RO) and water reuse in China. RO desalination research began in China in 1967 with the first ten years being devoted to translation of foreign papers on the subject into Chinese. From 1977-1980 rapid progress was made in the area of membrane research. Two kinds of aromatic polyamide hollow fiber and a kind of honeycomb dynamic formed membrane module and desalination equipment were developed. In recent work much of the emphasis has been aimed at solving RO theoretical questions and problems that arise during practical application of the technique. Problems currently being researched include the development of materials for membranes for special purposes, development of chemical products, and shortening of the cycle of production. Steps are being taken to increase the testing period of RO

service life before producing the equipment, to select good plants for manufacturing RO equipment, to pay great attention to the equipment used in the pretreatment process and increase the investment for pretreatment to 1/4 to 1/3 of the total budget, and to train accomplished operators. (Baker-IVI)
W84-02079

EXPERIENCE WITH DESALINATION OF SEA AND BRACKISH WATER USING MINIMUM PRETREATMENT AND HIGH TEMPERATURE,
Danske Sukkerfabrikker, Nakskov. Reverse Osmosis Div.
W. K. Nielsen.
Desalination, Vol. 46, p 67-79, 1983. 6 Fig, 6 Tab, 8 Ref.

Descriptors: *Desalination, *Membranes, Membrane processes, Seawater, Brackish water, Reverse osmosis, Costs.

In 1980 a new thin film composite membrane was introduced. This membrane can operate at high temperatures in the range of 0-80 C. Cleaning can be performed with acid and alkaline chemicals in a pH range of 1-12.5. The HR95/98 membranes in the plate-and-frame configuration give a combination which has proven to be extremely dependable. Multi-media filtration and security screens are frequently satisfactory as pre-treatment. Depending on the composition of the water, chemical additions are reduced compared to conventional reverse osmosis operation. The plants are designed as continuous plants with recirculation which has proved to give high security of operation and a high degree of flexibility in operating range. Compared to desalination with cellulose acetate membranes the new technology offers several advantages amongst which membrane stability, plant security against failures, reduce chemical and pretreatment costs and safe operation are the most predominant. (Author's abstract)
W84-02080

TEST RESULTS ON FT-30 EIGHT-INCH-DIAMETER SEAWATER AND BRACKISH WATER REVERSE OSMOSIS ELEMENTS,
FilmTec Corp., Minneapolis, MN.
R. E. Larson, R. J. Peterson, and P. K. Eriksson.
Desalination, Vol. 46, p 81-90, 1983. 4 Fig, 11 Ref.

Descriptors: *Desalination, *Reverse osmosis, Membrane processes, Seawater, Brackish water, Membranes.

Spiral-wound reverse osmosis elements formed of FT-30 membrane have been used for a variety of desalting applications around the world. The membrane was originally developed to satisfy the requirement for a true single-pass seawater membrane that would maintain its salt rejection characteristics while operating in a variety of seawater feeds. Later test results proved its applicability as a brackish-water desalting membrane as well, and FT-30 elements are now operating over a broad spectrum of feedwaters, ranging from tapwater to difficult industrial separations. The FT-30 membrane is noncellulosic and is of a thin-film composite configuration. It satisfies the main requirement of having high flux and excellent salt rejection, but in addition it is chemically stable, can operate over a broad range of pH, is partially resistant to chlorine exposure and shows good stability at high feedwater temperatures. These latter characteristics facilitate both acid and caustic cleaning, an important consideration under fouling conditions. Considerable field application experience has been obtained with FT-30 membrane elements over the past three years. This experience has given excellent results, although it has been limited to small elements - the largest manufactured by FilmTec until recently was 4 x 21 inches and gave 600 gpd on seawater and 1200 gpd on brackish water. In early 1982 4 x 40-inch elements began to be produced and used commercially. Then in the summer of 1982, 8 x 40-inch elements were manufactured for the first time, meeting the design goals of single-pass seawater performance with product flows of over 5,000 gpd, and under brackish water conditions with flows of over 10,000 gpd. These large elements are now being tested on seawater and brackish water feeds in the Mid-East, in England, in Florida, and in several other locations. Single-pass seawater performance data and brackish-water test results are presented. Eight-inch elements are now being produced in commercial quantities for use in large reverse osmosis installations. (Author's abstract)
W84-02081

ULTRAFILTRATION MEMBRANE PROCESSES - THE SLEEPING GIANT,
RQ Associates, Inc., Teaneck, NJ.
R. M. Quinn.
Desalination, Vol. 46, p 113-123, 1983. 9 Fig.

Descriptors: *Desalination, *Membrane processes, Ultrafiltration, Filters.

Ultrafiltration processes and systems are reviewed and evaluated. Hollow fiber, spiral wound, and tubular systems and their relative process and cost advantages are reviewed. The effects of process parameters such as foulants in feed water, temperature, operating pressure and flux on process design and system configuration are considered. The paper can serve as an introduction to ultrafiltration for those who are not yet familiar with the technology. The ability of current membranes to treat a variety of streams, and the need for purer products and more effective concentration/separation processes are creating a renewed interest in the field. (Baker-IVI)
W84-02082

DESALINATION OF HIGH SALINITY SEA WATER BY REVERSE OSMOSIS (SUMMARY),
Water Reuse Promotion Centre, Tokyo (Japan).
Y. Kunisada, K. Okada, M. Tsureish, K. Kikuchi, and M. Hirai.
Desalination, Vol. 46, p 145-150, 1983. 2 Fig.

Descriptors: *Desalination, *Seawater, *Reverse osmosis, Water temperature, Salinity.

Performance tests were carried out on three new reverse osmosis modules for single pass desalination of high salinity and high temperature seawater, developed by Japanese manufacturers. Experiments were carried out on HR5350S module under the conditions of feed water salinity 42,000 mg/l, feed water temperature 40 degrees C, operating pressure 54 kg/sq cm and recovery ratio 30% for 3,000 hours, on SP-210 module under the conditions of feed water salinity 42,000 or 50,000 mg/l, feed water temperature 35 or 40 degrees C, operating pressure 56 or 63 kg/sq cm and recovery ratio 35-25% for 4,260 hours and on SP-110X module under the conditions of feed water salinity 50,000 or 55,000 mg/l, feed water temperature 30 or 35 degrees C, operating pressure 63 kg/sq cm and recovery ratio 25-21% for 1,640 hours. TDS of the product water were about 200 mg/l, less than 200 or about 250 mg/l and 210-220 mg/l respectively. Each module showed stable performance. (Author's abstract)
W84-02083

SOLUTION OF CONTRADICTORY PROBLEM OF SIMULTANEOUS DESALINATION AND CONCENTRATION IN REVERSED OSMOSIS,
C. A. Yagodin, B. F. Nikolsky, N. F. Kuleshov, and A. A. Svitsov.
Desalination, Vol. 46, p 171-177, 1983. 3 Ref.

Descriptors: *Desalination, *Reverse osmosis, Sea water, Brines, Water supply, Desalination wastes.

The optimum relation must be established between the volumes of water and brine, when the reverse osmosis process is used to desalinate and purify water. A method of calculation of the optimum relation for reverse osmosis units takes into account the inconsistency of the task of simultaneous desalination and concentration of salt solutions. In testing the procedure it was determined that the method permitted a reduction in the volume of wastes discharged from reversed osmosis units to the environment. By developing the flow sheets of reverse osmosis units using the derived dependencies it was possible to calculate the cross sectional area of the membrane apparatus along the path of a solution being separated. It was possible to calculate the capacity and quality of permeate in each section, the degree of concentrating in the whole unit and its individual parts. (Baker-IVI)
W84-02084

DESIGN AND FIELD TRIALS OF A 200 CU M/DAY SEA WATER DESALINATION BY ELECTRODIALYSIS,
National Bureau of Oceanography, Hangzhau (China). Second Inst. of Oceanography.
S. Shi, and P.-Q. Chen.
Desalination, Vol. 46, p 191-196, 1983. 2 Fig, 2 Ref.

Descriptors: *Desalination, *Electrodialysis, Water supply development, Membrane processes, China, Meishan Island.

A 200 cu m/day sea water desalination plant using electrodialysis has been developed. The plant consists of ten stages divided into two groups, modified on the basis of the plant containing twelve stages with three groups. Ruthenium-coated titanium wire electrodes are used for anode and cathode, electrode compartments are rinsed by high velocity and electrode polarity is reversed periodically, so the plant does not need any acid during operation. Field trials on the first and the modified plants were carried out for 1500 and 350 hours, respectively on Meishan Island along the coast of Zhejiang Province in 1978 and 1979. The performances of both plants have been proved to be stable, but the latter is more simple and more economical than the former one. The water produced must be sterilized if it is to be used for drinking purposes. (Baker-IVI)
W84-02085

ADSORPTION - DESORPTION STACK FOR CYCLIC ELECTRODIALYSIS IN OPEN SYSTEM,
M. E. Abu Goukh, and D. W. Thompson.
Desalination, Vol. 46, p 211-223, 1983. 8 Fig, 1 Tab, 9 Ref.

Descriptors: *Desalination, *Electrodialysis, Scaling, Membrane processes, Cyclic electrodialysis, Scaling.

The main problems encountered in conventional electrodialysis, ED, are reviewed. Cyclic electrodialysis is proposed as an attractive alternative with ability to circumvent the main problems in the standard unidirectional process; namely, the scale formation and membrane fouling. The main design and operation features of cyclic electrodialysis are discussed and compared with those of conventional electrodialysis. Design and operating features of an adsorption-desorption stack which is suitable for cyclic electrodialysis are presented. Stack capability has been demonstrated using aqueous sodium chloride solution under different operating conditions of feed concentration, production rate, applied voltage, cycle timing and demineralizing path length. A separation factor as high as 65 was obtained in an open system, while separation factors of the order 1000 had been obtained in a closed system. (Author's abstract)
W84-02086

CHARACTERISTICS OF FLOW AND MASS TRANSFER RATE IN AN ELECTRODIALYZER COMPARTMENT INCLUDING SPACER,
Hitachi Research Lab., Ibaraki (Japan).
O. Kuroda, S. Takahashi, and M. Nomura.
Desalination, Vol. 46, p 225-232, 1983. 11 Fig, 5 Ref.

Descriptors: *Membrane processes, *Desalination, *Ion exchange, Mass transfer, Flow rate, Electrodialysis.

In order to determine the optimum compartment structure and operation conditions for electrodialy-

sis, the hydraulic characteristics and mass transfer promoting ability of net-type (mesh) spaces inserted in a compartment were investigated. The relation between spacer structure and these two characteristics were examined in experiments through an electrochemical reaction of the redox system. Between the fluid friction coefficient and Reynolds number the relation was established with channel intervals, the gaps between spaces and channel walls, and mesh size. Mass transfer promotion characteristics were measured electrochemically. The spacers with larger mesh showed a higher promotion effect at relatively low pressure loss for constant channel intervals. This demonstrated that more effective spacers could be developed by adjusting the mesh sizes. Temperature variation of mass transfer coefficients obtained coincided with temperature variations of the limiting current density for electrodialysis. (Baker-IVI)
W84-02087

CHANGES IN WATER AND SALT TRANSPORT DURING HYDROLYSIS OF CELLULOSE ACETATE REVERSE OSMOSIS MEMBRANES,
California Univ., Los Angeles.
J. Glater, and S. McCray.
Desalination, Vol. 46, p 389-397, 1983. 4 Fig, 2 Tab, 10 Ref.

Descriptors: *Desalination, *Cellulose acetate membranes, Membrane processes, Reverse osmosis, Water transport, Permeability coefficient, Hydrolysis.

Cellulose acetate membranes undergo hydrolytic decomposition which is accelerated at very high or low pH levels. Hydrolysis results in the loss of acetyl groups leading to a sharp decline in membrane performance. Minimum hydrolysis rates occur in the pH range of 4-6. The two parameter transport equation gives salt and water permeability coefficients which depend on membrane acetyl content. In this paper both coefficients, calculated from performance changes are shown, to increase exponentially with time. Rate constants calculated from these changes show changes in salt permeability to be an order of magnitude greater than changes in water permeability. The observed discrepancy in salt and water transport kinetics suggests differing mechanisms for these two processes. Evidently, salt-water coupling during transport increases as membrane hydrolysis progresses. Thus, the two parameter transport equations do not apply since they neglect the salt-water coupling phenomenon. The use of other membrane transport models to account for changes in membrane performance as hydrolysis occurs is discussed. The relation between acetyl content and hydrolysis rates is also considered. (Baker-IVI)
W84-02089

DESALINATION PLANT PROGRAM TO SOLVE SHORTAGE OF WATER IN THE SOUTHERN ITALIAN ISLANDS (SICILY),
Cassa per il Mezzogiorno, Rome (Italy).
G. Consiglio, and M. Creton.
Desalination, Vol. 45, p 209-220, 1983. 8 Tab.

Descriptors: *Desalination plants, *Management, Sicily, Italy, Water supply, Contracts.

An original form of contract is presented which provides a single call for tenders for installing six desalination plants in some small islands of Sicily and binds the contractor to the possible operation of all the plants concerned for an eleven year period. The use of water desalination plants is the major method of supplying enough water for several of the small Sicilian islands. The main choices made in implementing the desalination plant program consist of entrusting the contractor with the operation of the desalination plant for a considerably long time of up to 11 years, arranging a single tender covering all the desalination plants on a turn-key basis, or giving the companies the choice to select the kind of desalination processes. Once the tender has been established, the goals of the tender were set as follows: comprehensive bids for design, supply and installation of six desalination plants, with relative power generating stations and civil works; comprehensive bids for the operation of all the plants and auxiliaries for the first year following acceptance of the plant; and the commitment to operate the desalination plants and auxiliaries for a further 10 year period with coverage of any expenditure needed for maintenance and operation. (Baker-IVI)
W84-02090

DESIGN AND PERFORMANCE OF THE WORLD'S LARGEST OPERATING DUAL-PURPOSE SEA WATER DESALTING PLANT,
INCON Anlagentechnik G.m.b.H., Homburg/Saar (Germany, F.R.).
F. G. Abbosh, I. Kamal, S. Chalchal, and H. Gerke.
Desalination, Vol. 45, p 223-230, 1983. 2 Fig, 2 Tab.

Descriptors: *Desalination, *Water treatment facilities, Water supply development, Water shortage, Saudi Arabia, Jeddah, Scaling, Corrosion, Powerplants, Chlorination, Control systems, Seawater.

The 500 MWe/220,000 cu m/day Jeddah 4 Power and Desalination Plant is the largest operating dual-purpose plant in the world. It was needed in Saudi Arabia to meet the growing water and power requirements of the Jeddah area. The plant is based on 5 boilers and turbogenerator sets, each producing 100 MW net electrical power. A novel feature of Jeddah 4 is its sophisticated instrumentation, control and computer system which provides for complete central operation and control from the main control room. All these systems are designed for fail-safe operation, and plant availability is assured by provision of manual control back-up for all major plant items. Owing to adequate control of tube-fouling and low non-equilibrium losses, performance ratios are 10 to 20% better than design. Production levels are 10% above design, with steam consumption below the design values. Scale control has been based on dosing with sulfuric acid at less than the stoichiometric amount, leaving a residual alkalinity of about 10 ppm in the make-up feed. The seawater feed to the Jeddah 4 plant is continuously dosed with chlorine at a rate of 2 ppm. During early stages of operation a gradual loss in vacuum was observed after the 4 stage ejector/barometric condenser system had been in operation of 6-10 hours. External and internal corrosion of stainless steel pipes, aggravated by the aggressive ambient atmosphere and possible contact with stagnant sea water was noted and corrected. (Baker-IVI)
W84-02091

THERMAL DESALINATION OF SEA WATER IN THIN FILM PLANTS,
Dalnevostochnyi Politekhnicheskii Inst., Vladivostok (USSR).
V. N. Slesarenko.
Desalination, Vol. 45, p 295-302, 1983. 4 Fig, 6 Ref.

Descriptors: *Desalination plants, *Seawater, *Thin films, Heat exchangers, Hydrodynamics, Desalination, Entrainment, Scaling.

A further improvement of desalination plants calls for finding new ways on intensification of their working process. This can be achieved by using heat exchangers with thin film liquid supply in the flow sheet of a plant, the apparatus being characterized by a high-efficiency heat exchange. Hydrodynamics and heat exchange were investigated in desalination plants in which a liquid is fed to the heating surface due to rising entrainment of film by a hot air flow and free washing of a horizontal surface. The intensity of heat exchange in horizontal and rising film heat exchangers are 2-3 times higher than in the other types of desalination plants. Temperature differences are rather low, which prevents scale formation on the heating surface. The coefficients for sea water are 15-20% higher than those for distillate, confirming the conclusion about the impossibility of using data obtained on distillate and single component brines in design methods. (Baker-IVI)
W84-02092

INVESTIGATION OF WATER DESALINATION BY DISTILLATION TECHNIQUE,
N. M. Sinev, V. G. Shatsillo, V. B. Chernozobov, A. A. Samarkin, and Ju. S. Baranov.
Desalination, Vol. 45, p 315-320, 1983. 1 Tab.

Descriptors: *Desalination, *Distillation, Evaporation, Scaling, Corrosion control, Shevchenko, USSR.

The main large stationary desalination units of different types developed in the USSR and used in the design of the largest plant in Shevchenko having the output of 100000 cu m/day of distillate is described. The plant operates in close interrelation with an atomic thermoelectric 5H-350 fast reactor plant and back pressure turbines. Some results of constantly performed studies into heat transfer, vapor separation, control of scale deposits and corrosion are discussed along with results of searching for new thermal systems and instruments to be used for the improvement of operating distillation desalination units and the development of new ones. Further prospects of thermal desalination are associated with the use of multi-stage units equipped with horizontally arranged tube film evaporators. (Author's abstract)
W84-02093

DESALINATION PLANT CONTROL WITH MICROPROCESSOR BASED DIGITAL TECHNOLOGY,
Honeywell Europe S.A., Brussels (Belgium). Process Management Systems.
G. O. Hultin, and R. Harper.
Desalination, Vol. 45, p 329-336, 1983. 4 Fig, 1 Ref.

Descriptors: *Desalination plants, *Corrosion control, *Digital computers, Microprocessors, Computers, Automation.

The success of improved control strategies for minimizing corrosion and for improving plant operation efficiency is dependent on the data acquired from the process. To obtain improvements in control, more data than is now generally available will have to be collected. Distributed microprocessor based digital technology with a hierarchical system approach provides effective tools for on-line corrosion control by making use of the available historization, trending and alarming features. The hierarchical system structure facilitates improved production efficiency at different levels of sophistication, from a basic control concept to an automatically optimized operation by making use of thermodynamical steam and water properties. A high level of reliability is reached through this system structure, making costly solutions with redundant computers unnecessary. (Author's abstract)
W84-02094

RECENT SOLAR DISTILLATION DEVELOPMENTS,
A. Delyannis, and E. Delyannis.
Desalination, Vol. 45, p 361-369, 1983. 7 Fig, 1 Tab, 13 Ref.

Descriptors: *Desalination, *Water supply, *Solar distillation, SOLERAS Project, Potable water, Distillation, Rain, Wind energy, Arid areas.

In arid areas rain is often collected and stored to be used as fresh water supply over the year. Solar distillation may provide potable water for remote locations where other water supply systems are not available. Since the intensity of solar radiation per unit of evaporating area is determined by nature, the output of a solar distillation unit in a given location can only be increased by increasing the evaporating surface. Solar distillation can never be a steady operation due to changes in intensity of the sun during the day. There are two ways of increasing the fresh water yield in connection with standard greenhouse distillation units. The first is rain collection. The second way of increasing the efficiency of conventional greenhouse type solar stills is to use preheated water or waste hot water as the feed. Use of more effective desalination

processes of proven technology, instead of conventional greenhouse type solar distillers, results in higher efficiencies. Direct or indirect utilization of solar energy may also be combined with other desalination processes, without necessarily having the production of hot water as intermediate stage. Wind energy to produce electricity or photovoltaics may be combined with reverse osmosis or electrodialysis. (Baker-IVI)
W84-02095

DESALINATED WATER PRODUCTION AT LNG-TERMINALS,
Nuovo Pignone S.p.A., Florence (Italy).
A. Antonelli.
Desalination, Vol. 45, p 383-390, 1983. 2 Fig.

Descriptors: *Desalination, *Fuels, *Liquefied natural gas, Natural gas, Sea water, Thermodynamics, Freezing.

A process has been worked out to apply the laws of thermodynamics to sea water desalination making use of liquefied natural gas (LNG). Ambient temperature heat is applied to LNG which evaporates and generates power. This power is employed to extract heat from sea water, part of the sea water is frozen and the heat is discharged to the environment. The ice produced is melted at ambient temperature and desalted water is obtained. Conventional technology is used for every component of a plant using this method. This type of plant may produce quite a substantial amount of desalted water, up to 3.2 tons of water per ton of LNG. Therefore a terminal capacity of 5,100,000,000 NM3/yr of natural gas may produce 10,000 t/d of water, equivalent to the needs of a town of 40,000 inhabitants. (Baker-IVI)
W84-02096

REVERSE OSMOSIS MEMBRANE SENSITIVITY TO OZONE AND HALOGEN DISINFECTANTS,
California Univ., Los Angeles. Dept. of Chemical, Nuclear, and Thermal Engineering.
J. Glater, M. R. Zachariah, S. B. McCray, and J. W. McCutchan.
Desalination, Vol. 48, p 1-16, 1983. 10 Fig, 3 Tab, 13 Ref.

Descriptors: *Desalination, *Reverse osmosis, *Disinfectants, Membranes, Ozone, Chlorine, Iodine, Cellulose acetate membranes, Polyamides, Bromine, Hydrogen ion concentration.

The sensitivity of commercial reverse osmosis membranes toward halogen and ozone disinfectants has been measured at carefully controlled concentration and pH levels. Membrane sensitivity varies with polymer type, disinfectant chemical, and solution pH. Aromatic polyamide membranes are damaged by halogen addition to aromatic rings within the polymer. This process follows predictable reaction kinetics. Polymer viscosity changes with increasing membrane damage have also been followed. Cellulose acetate membranes are generally resistant to halogens and halogen derivatives. Polyamide type membranes are sensitive to chlorine and bromine but show reasonable resistance with appropriate pH control. Ozone will damage any membrane tested, but cellulose acetate shows some resistance at low pH levels. This type of membrane may resist low concentrations in systems designed for ozone disinfection. All membranes are generally resistant to iodine. Polyamide type membranes are generally resistant to chlorine dioxide at near neutral pH. This chemical evidently attacks membranes at high pH by oxidation since no halogen uptake is noted. DuPont B-9 membrane chemically combines with chlorine during exposure. This process is accompanied by decreasing viscosity of polymer solutions in dimethyl sulfoxide. Chlorine uptake data follows pseudo-first reaction kinetics. (Baker-IVI)
W84-02097

SHORT CUT DESIGN METHODS FOR REVERSE OSMOSIS SEPARATION WITH TUBULAR MODULES,
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Chemistry and Chemical Engineering.
K. K. Sirkar, and G. H. Rao.
Desalination, Vol. 48, p 25-42, 1983. 2 Tab, 14 Ref.

Descriptors: *Desalination, *Reverse osmosis, Turbulent flow, Mathematical equations.

The basis for obtaining explicit flux expressions in reverse osmosis separations with concentration polarization has been illustrated for tubular modules with turbulent flow. Various analytical equations developed thereby to predict the required number of tubes and the permeate solute concentrations are described and compared with one another as well as with the currently used numerical methods. The utility of such simple design procedures are pointed out. The possibilities and difficulties of adopting these procedures for designing spiral-wound modules have been discussed. The analytical equations can be adopted to 'tapered-flow' reverse osmosis without much difficulty. (Author's abstract)
W84-02098

POLYPIPERAZINAMIDES: NEW POLYMERS USEFUL FOR MEMBRANE PROCESSES,
Istituto Guido Danegani S.p.A., Novara (Italy).
P. Parrini.
Desalination, Vol. 48, p 67-78, 1983. 14 Fig, 5 Ref.

Descriptors: *Desalination, *Membranes, Membrane processes, Polypiperazinamides, Polymers.

A class of polymers based on piperazinamides is described. The structures and physical properties of main polymers are compared and the osmotic performance is examined. Among the polymers considered, the trans-2,5-dimethylpiperazinthiofurazan 3,4-amide was developed as a precursor for reverse osmosis. The osmotic properties of asymmetric membranes obtained from TFZ amides are reported. The resistance to temperature, to variations in pH and to chlorine and its derivatives are of great interest. This type of membrane assembled in different modules, is used in the desalination field as well as in other technological processes such as fluid treatment, the oenological field, and materials recovery. At present, 50 to 100 cm wide polypiperazinamide membranes are produced commercially. They are prepared on textile supports, so as to make their utilization in preparing spiral modules easier. (Baker-IVI)
W84-02099

PREVENTION OF CALCIUM SULFATE SCALE DEPOSITION BY A FLUIDIZED BED,
Technische Hogeschool, Delft (Netherlands). Dept. of Chemical Engineering and Chemistry.
J. A. M. Meijer.
Desalination, Vol. 47, p 3-15, 1983. 12 Fig, 15 Ref.

Descriptors: *Desalination, *Distillation, *Fluidized beds, *Scaling, Calcium sulfate, Seawater, Brackish water, Fouling, Evaporators, Hemihydrate, Anhydrite.

The scale inhibiting capability of a fluidized bed in the vertical heat exchanger tubes of a Multi Stage Flash/Fluidized Bed Evaporator (MSF/FBE) was investigated. The MSF/FBE is a vertical flash evaporator used for the distillation method of converting sea and brackish water into fresh water. This method possesses excellent features with respect to investment costs, specific heat consumption and prevention of fouling and scaling. The temperatures at which calcium sulfate scale starts to deposit despite the abrasive action exerted on the wall by fluidized bed particles was determined. In all experiments the calcium sulfate hemihydrate solubility line could be exceeded to a certain extent without scale deposition. At concentration factors of sea water larger than 2.5 hemihydrate was found, while at lower concentrations factors anhydrite was deposited. The highest top temperatures were reached when the brine was deaerated and recirculation of seeding crystals was excluded. Scale deposition is prevented more efficiently by 2 or 3 mm glass particles than by 1 mm glass particles. A model is given to describe the competitive processes of scaling and abrasion at the wall of the heat exchanger tubes. Both processes were studied separately. The removal rate of calcium sulfate crystals were determined by abrasion tests and experiments in a scaled up fluidized bed; and the growth rate of calcium sulfate by experiments in a high temperature rotating disc reactor. (Baker-IVI)
W84-02100

APPLICATION OF A HIGH TEMPERATURE SCALE CONTROL ADDITIVE IN A MIDDLE EAST MSF PLANT,
Nalco Italiana S.p.A., Rome (Italy).
G. F. Casini.
Desalination, Vol. 47, p 19-24, 1983. 5 Fig.

Descriptors: *Desalination, *Scaling, *Corrosion control, Nalco 8599-NI, Distillation, Seawater, Evaporators, Crystallization, Water temperature.

A new antiscale product, Nalco 8599-NI, was tested for its effectiveness in a sea water evaporator located in the South-East end of the Arabic peninsula, operating with Gulf water. The inhibitor incorporates a specific dispersant agent, is supplied in liquid form and is miscible with sea-, fresh- or distilled water at any proportion. Nalco 8599-NI is effective as regards growth of both crystallization nuclei and pre-existing crystals in that a double layer of electrical charges is created. In the first case, a distortion of the crystallographic growth plans occurs and the growth of the microcrystal is inhibited. In the second case, the double electric layer has a dispersant action and the crystal, therefore, will no longer originate scale. The altered structure and the strong dispersive action allow the particles to be easily transported from the system at normal flow rates. The Nalco 8599-NI proved effective at 7 ppm at a brine temperature of up to 110 degrees C. The product was also shown effective at 5-6 ppm for the same temperature level. Lower dosages may be used when the top temperature of the brine is less than 110 degrees C. (Baker-IVI)
W84-02101

SCALE CONTROL INHIBITOR PERFORMANCE AT 100 DEGREES C UNDER BOILING CONDITIONS,
Mechanical Equipment Co., New Orleans, LA.
R. W. Goeldner.
Desalination, Vol. 47, p 25-35, 1983. 3 Fig, 4 Ref.

Descriptors: *Desalination, *Scaling, Distillation, Corrosion control, Additives, Temperature.

Trials were conducted using commercially available high temperature threshold additives with a packaged vapor compression distiller to study the performance of these chemical in distillation plants which operate with boiling brine in contact with heat transfer surfaces at elevated temperatures. The vapor compression distiller uses vertical fluted tubes in an upflow natural circulation mode and operates just above atmospheric pressure. Some of the chemicals tried are those which have enabled a number of large MSF distillers to operate for thousands of hours between cleanings at terminal temperatures of over 100 C. Improvements made in chemical treatment as part of the test program have resulted in extending the time period between cleanings five fold. It is believed that these improvements can be used to make threshold type scale inhibition a practical reality in large scale high temperature multi-effect and vapor compression distillers as well as many MSF plants which have not responded favorably to conventional high temperature additives. (Baker - IVI)
W84-02102

ASSESSMENT OF DIFFERENT SCALE CONTROL METHODS,
Technische Hochschule, Aachen (Germany, F.R.). Inst. fuer Verfahrenstechnik.
R. Rautenbach, H. Offermann, and E. E. Hammer.
Desalination, Vol. 47, p 49-62, 1983. 18 Fig, 11 Ref.

Descriptors: *Desalination, *Scaling, *Distillation, Ion exchange, Cost analysis, Additives, Cation exchange.

Distillation plants, operating at least partially well above ambient temperature, must be protected against scaling. In principle, this can be achieved by a number of different processes - eight of which are examined and assessed. These studied included additive dosing, acid dosing, lime magnesium carbonate-process, thermal precipitation, cation exchange, seeding processes, coated or polished surfaces, on line mechanical cleansing and additive dosing. According to a cost-benefit analysis ion exchange seems to be an interesting alternative to additive dosing. The comparison between fixed bed and moving bed ion exchange in the range of capacities between 200 and 20000 t/d distillate indicates that moving bed ion exchange is less advantageous than a fixed bed process. This statement is particularly valid for small and medium-sized plants. At present more information is needed concerning service life time, the rate of resin-destruction within the recirculating pumps of the moving bed process, and the rate of resin-destruction be osmotic shock in the fixed bed process. It is suggested that a reduction of about 10% of the specific water cost is possible if the feed of a single purpose MSF plant is treated by ion exchange instead of additive dosing. It must be emphasized, however, that a possible reduction of this 10% is exactly of the same order as the range of accuracy of the cost estimate. As energy prices increase, the decision will shift in favor of the ion exchange process. (Baker-IVI)
W84-02103

EVALUATION OF THERMAL DESALINATION PLANTS WATER CHEMISTRY,
Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Inst., Moscow (USSR).
O. I. Martynova, L. G. Vasina, A. V. Baglovsky, D. P. Yegorov, and L. P. Karnauknov.
Desalination, Vol. 47, p 63-69, 1983. 2 Fig, 1 Tab, 6 Ref.

Descriptors: *Desalination plants, *Water chemistry, *Scaling, Evaporation, Acids, Mass transfer.

One major problem in desalination plant improvements remains the development of new, more effective methods of optimal water chemistry regimes maintenance. Scale formation is determined by two interconnected processes: transport of matter to the growing crystal surface due to convective mass transfer and surface reaction penetrating into the crystal lattice. For the purpose of decreasing scale formation intensity, enclosure of a thermo-softener apparatus directly before the evaporator stage was considered. Due to substantial crystallization in the thermo-softener apparatus, there was a decrease of scale forming components entering the evaporators. A significant redistribution of carbonic acid components was also noted with a relative increase of carbonate and hydroxyl ions. By monitoring scale growth regularities during the incubation period and mass transfer processes the optimal regime of acid impulse addition can be maintained. The ease of the operation, significantly lower acid input, and lessened corrosion intensity, make this method more promising than the continuous acidification methods. (Baker-IVI)
W84-02104

DESULPHATION NEW APPLICATIONS: DOHA EAST(KUWAIT) AND GELA (ITALY) DESALINATION PLANTS,
Reggiani Omi S.p.A., Reggio Emilia (Italy).
R. Zannoni, A. de Maio, G. Odone, F. Fioravanti, and G. Boari.
Desalination, Vol. 47, p 93-102, 1983. 5 Fig, 5 Tab, 6 Ref.

Descriptors: *Desalination, *Scaling, *Desulfation, Calcium sulfate, Seawater, Italy, Kuwait.

The desulfation treatment, designed and processed by Reggiane under a C.N.A. patent, is an advanced method for sea water make-up treatment in MSF desalination plants. This process, applied to plants with acid treatment, avoids calcium sulfate scale on the heat exchange surfaces and increases the top brine temperature, with higher plant performance ratio. Doha East-Kuwait, is designed for the treatment of a make-up flow of 480 cu m/h and a top brine temperature of 138 C (280 F), and will linked up with a desalination plant (1 MIGPD), currently being built. Start-up and plant test are scheduled for the last six months of 1983. The second unit, Gela-Italy, has been projected to be annexed to one of the existing four MSF desalination plants sited in the ANIC Petrochemical Plant in Gela-Italy, to eliminate severe calcium sulfate scaling problems and to restore the projected standards actually not met. The desulfation unit will allow the treatment of a sea water make-up flow of 1200 cu m/h with a top brine temperature of 130 C (265 F). (Baker-IVI)
W84-02105

RO DESALTING OF BRACKISH WATER OVERSATURATED WITH CASO4,
Mekoroth Water Co., Tel Aviv (Israel).
M. Wilf, and J. Ricklis.
Desalination, Vol. 47, p 209-219, 1983. 3 Fig, 1 Tab, 9 Ref.

Descriptors: *Desalination, *Reverse osmosis, Brackish water, Salinity, Calcium sulfate, Cost analysis, Financial aspects.

The possibility of recovery increase in the commercial reverse osmosis plant, desalting brackish feed of 5000 ppm total dissolved solids salinity, was tested in a pilot plant equipped with 4 inch spiral wound and hollow fiber modules. The plant desalted the reject stream from the commercial plant. Long term field tests of up to 4000 hr on membrane performance were conducted. During the tests the ratio of the calcium and sulfate ion concentrations product to the formal solubilities of calcium sulfate at the corresponding ionic strength was maintained in the range of 1.2 to 2.3. Stable membrane performances were obtained with respect to productivity and salt rejection. Based on the field results a 900 cu m/d unit for reject desalting was constructed. The unit enabled an increase of the product recovery in the commercial plant to 65% from a design value of 53%. Difficulties which had been encountered in earlier long term tests such as feed component depletion and foulant accumulation during the test period were avoided by the once through flow of the feed in the experimental system. The stable performance of the membranes indicated that it would be possible to operate the commercial reverse elements at much higher concentrations of sparingly soluble salts that the safe limits accepted thus far. A substantial margin exists which can be exploited for better desalting economics. (Baker-IVI)
W84-02107

CONTROL OF BIOLOGICAL FOULING IN SEAWATER REVERSE OSMOSIS DESALINATION,
Fairleigh Dickinson Univ., Teaneck, NJ. Dept. of Biological Sciences.
H. Winters, I. Isquith, W. A. Arthur, and A. Mindler.
Desalination, Vol. 47, p 233-238, 1983. 7 Ref.

Descriptors: *Desalination, *Reverse osmosis, *Membrane processes, Scaling, Microorganisms, Chlorination, Ferrous sulfate, Citric acid, Tannic acid, Polyacrylate, Seawater.

Various non-acid pretreatment schemes were studied in a seawater reverse osmosis desalination plant for one year. Particular attention was given to microbial aspects of fouling. Four different approaches to non-acid pretreatment were considered: chlorine starvation by the use of minimal chlorine which just satisfied the chlorine demand of the seawater coupled with ferrous sulfate coagulation and dechlorination; addition of organic antiscalant; addition of citric acid as an antiscalant; and addition of tannic acid as an antiscalant and antifoulant. Both polyacrylate and tannic acid showed some promise as an alternative to acid pretreatment and chlorination. A new assay was developed which holds promise for predicting the potential of any feed water sample to promote microbial fouling. (Baker-IVI)
W84-02108

DESALINATION OF COALMINE DRAINAGE WATER BY REVERSE OSMOSIS,
Binnie and Partners, London (England).
R. C. Squires, J. A. C. Cowan, and F. C. Wood.
Desalination, Vol. 47, p 343-350, 1983. 5 Fig, 1 Tab.

Descriptors: *Desalination, *Mine drainage, *Reverse osmosis, Ion exchange, Coal mines, Membranes, Wastewater treatment, Wastewater renovation.

A small pilot plant has been built and operated to study the treatment of a mine drainage water of bicarbonate type to render it suitable for use as boiler feed make-up or disposal. To avoid the need for excessive dosing with acid, pre-softening of the feed by ion exchange was adopted and a range of types of reverse osmosis membranes comprising tubular, spiral-wrap and hollow-fine fiber geometries was tested. Best results were obtained with thin-film composite type membranes, salt rejection of over 99% being obtained in a single-pass operation with recyle of concentrate. The preferred process also makes possible the recovery of soda ash from the minewater, after thermal concentration. (Author's Abstract)
W84-02115

3B. Water Yield Improvement

POTENTIAL FOR WATER YIELD AUGMENTATION FROM FOREST MANAGEMENT IN THE EASTERN UNITED STATES,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
J. E. Douglas.
Water Resources Bulletin, Vol. 19, No. 3, p 351-358, June, 1983. 6 Fig, 2 Tab, 34 Ref.

Descriptors: *Water yield improvement, *Forest management, Streamflow, Land management, Water demand, Eastern United States.

Generally high rainfall and extensive forests in the East combine to produce excellent potential for managing forests for increased water yield. Models are presented that allow prediction of streamflow increase from hardwood and pine forests on a year-by-year basis. They are being routinely applied in land management planning on National Forests in the Southeast. A recent, independent test indicates that cumulative water yield increases can be predicted within about 14% of the actual value. However, because of the diverse land ownership patterns and the economic objectives of owners, realizing the full potential appears greatest where the land is publicly owned, but demand for water in the East has not reached the point where need for water dictates management prescriptions. (Author's abstract)
W84-01920

POTENTIAL FOR WATER YIELD AUGMENTATION FROM FOREST MANAGEMENT IN THE ROCKY MOUNTAIN REGION,
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
C. A. Troendle.
Water Resources Bulletin, Vol. 19, No. 3, p 359-373, June, 1983. 17 Fig, 4 Tab, 30 Ref.

Descriptors: *Forest management, *Water yield improvement, *Rocky Mountains, Cutting management, Subalpine zone, Lapine zone, Evapotranspiration, Snowpack, Forest hydrograph.

With the exception of the Sierra-Cascade mountain ranges, the Rocky Mountain chain is the only portion of the western United States that consistently yields more than 3 cm of flow annually. Ten to 15% of the land mass in the region produces the majority of the total flow. These source areas are primarily the high-elevation alpine and subalpine forest zones. Because of the dominant effect of the snowpack on the annual hydrograph, management opportunities in the snow zone are an integration of responses from snowpack manipulation as well as evapotranspiration modification. Water yield can be increased significantly through forest man-

agement while minimizing the detrimental effects in terms of peak discharges, erosion and sediment production, and channel integrity. Through prudent management, a 2 to 6 cm increase in flow from each ha of land managed to optimize water yield in the subalpine can be realized. The optimal harvest design appears to consist of small openings, irregularly shaped, and about 3 to 8 tree heights in width parallel to the wind. The amount available for such management is only a small portion of the total. Once under management, given a 100- or 120-year rotation, a maximum increase could be maintained from 1/4 to 1/3 of the managed land at any one time because of the effect of recovery. Augmenting water yield through forest management is a viable alternative in the Rocky Mountain region. (Moore-IVI)
W84-01921

WATER YIELD IMPROVEMENT POTENTIAL BY VEGETATION MANAGEMENT ON WESTERN RANGELANDS,
A. R. Hibbert.
Water Resources Bulletin, Vol. 19, No. 3, p 375-381, June, 1983. 3 Fig, 1 Tab, 42 Ref.

Descriptors: *Range management, *Water yield improvement, *Vegetation management, Brush control, Snow management, Chaparral, Shrubs, Aspen, Pinyon, Juniper, Grassland.

Increasing water for onsite and offsite uses can be a viable objective for management of certain western rangelands. An attractive alternative to water harvesting is to replace vegetation that uses much water with plants that use less so that more water percolates through the soil to streams and ground water. Most sites are too dry to increase water yield in this way; probably less than 1% of the western rangelands can be managed for this purpose. However, where annual precipitation exceeds about 450 mm (18 inches) and deep-rooted shrubs can be replaced by shallow-rooted grasses, there is potential to increase streamflows and to improve forage for livestock. The response to treatment appears to be largest in chaparral and somewhat less in other dense brushlands and in aspen. Small increases are possible by thinning ponderosa pine. Little or no increase can be expected by eradication of low-density brush and pinyon-juniper woodlands. On semidesert shrublands and grasslands, the only opportunity to increase streamflow is to increase the overland flow component. Some potential exists to increase water yield on high-elevation grasslands and sagebrush lands by management of blowing snow. With periodic maintenance to prevent shrub regrowth, the long-term water yield increase from chaparral conversion is expected to average 60 mm per year over areas actually converted. The expected increase for mountain brush is about 50 mm per year if conversion is maintained. Even larger increases are possible by removing aspen trees. (Moore-IVI)
W84-01922

POTENTIAL FOR AUGMENTING WATER YIELD THROUGH FOREST PRACTICES IN WESTERN WASHINGTON AND WESTERN OREGON,
Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab.
R. D. Harr.
Water Resources Bulletin, Vol. 19, No. 3, p 383-393, June, 1983. 6 Fig, 6 Tab, 15 Ref.

Descriptors: *Water yield improvement, *Forest management, *Washington, *Oregon, Seasonal distribution, Logging, Water demand, Fog interception, Phreatophytes.

Western Washington and western Oregon comprise a water-rich region that has a very uneven annual distribution of both precipitation and streamflow. Highest demand for water coincides with lowest streamflow levels between July 1 and September 30 when less than 5% of annual water yield occurs. Increases in annual water yield in small, experimental watersheds in the region have ranged up to 600 mm after entire watersheds were logged and up to 300 mm in watersheds that were 25 to 30% logged. Most of the increase has occurred during the fall-winter rainy season, and yield increases have been largest during the wettest years. Estimated sustained increases in water yield from most large watersheds subject to sustained yield forest management are at best only 3-6% of unaugmented flows. Realistically, watersheds in this region will not be managed to produce more water. Water yield augmentation will continue to be only a small and variable by-product of logging. The utility of water yield augmentation is limited by its size and by its occurrence relative to the time of water demand. In some local areas, reduction of fog interception and drip or establishment of riparian phreatophytic hardwoods may reduce summer flows. (Author's abstract)
W84-01923

POTENTIAL FOR INCREASING STREAMFLOW FROM SIERRA NEVADA WATERSHEDS,
Pacific Southwest Forest and Range Experiment Station, Soda Springs, CA. Central Sierra Snow Lab.
R. C. Kattelmann, N. H. Berg, and J. Rector.
Water Resources Bulletin, Vol. 19, No. 3, p 395-402, June, 1983. 3 Fig, 3 Tab, 42 Ref.

Descriptors: *Water yield improvement, *Watershed management, *Forest management, *Sierra Nevada, California, Vegetation management, Snowpack, Evapotranspiration, Snow interception, Streamflow delay.

The Sierra Nevada produces over 50% of California's water. Improvement of water yields from the Sierra Nevada through watershed management has long been suggested as a means of augmenting the state's water supply. Vegetation and snowpack management can increase runoff from small watersheds by reducing losses due to evapotranspiration, snow interception by canopy, and snow evaporation. Small clearcuts or group selection cuts creating openings less than half a hectare, with the narrow dimension from south to north, appear to be ideal for both increasing and delaying water delivery in the red fir-lodgepole pine and mixed-conifer types of the Sierra west slope. Such openings can have up to 40% more snow-water equivalent than does uncut forest. However, the water yield increase drops to 1/2-2% of current yield for an entire management unit, due to the small number of openings that can be cut at one time, physical and management constraints, and multiple use/sustained yield guidelines. As a rough forecast, water production from National Forest land in the Sierra Nevada can probably be increased by about 1% (0.6 cm) under intensive forest watershed management. Given the state of reservoir storage and water use in California, delaying streamflow is perhaps the greatest contribution watershed management can make to meeting future water demands. (Author's abstract)
W84-01924

WATERSHED MANAGEMENT FOR JOINT PRODUCTION OF WATER AND TIMBER: A PROVISIONAL ASSESSMENT,
Resources for the Future, Inc., Washington, DC.
J. V. Krutilla, M. D. Bowes, and P. Sherman.
Water Resources Bulletin, Vol. 19, No. 3, p 403-414, June, 1983. 4 Tab, 26 Ref.

Descriptors: *Forest management, *Watershed management, *Water yield improvement, *Cost analysis, Subalpine Zones, Snow interception, Evapotranspiration, Vegetation management, Wildlife, Logging, Hydroelectric power, Habitats.

Removal of forest canopy to reduce interception, evaporation, and transpiration, and to collect blowing snow, etc., increases water yield from small subalpine watersheds. The value of a program to increase streamflows is dependent upon the use made of such water and on the direct value from the vegetation manipulation. Possible benefits of water augmentation include: timber and fuel wood; habitat for desired wildlife species; hydroelectric generation; and the value of water for agriculture, municipal and industrial users. Associated costs include: the cost of access and vegetation removal; value of replaced habitat for displaced wildlife species; cost of facilities to utilize falling water; cost of water conveyance and distribution system; and the cost of conveyance for delivery. The value of a watershed management program was estimated using water yield data from Fool Creek, a 714-acre watershed in the Fraser drainage. It is assumed that a watershed is treated by harvesting 39% in appropriately shaped patches and that these areas are then harvested repeatedly at regular intervals. The value of water in this region is so great relative to timber that the reduction in water yield over time while waiting for the timber to mature to merchantable size incurs an opportunity cost which is not compensated by the value of the timber harvested. (Moore-IVI)
W84-01925

WATER YIELD AUGMENTATION THROUGH FOREST AND RANGE MANAGEMENT - ISSUES FOR THE FUTURE,
Forest Service, Fort Collins, CO. Watershed Systems Development Group.
S. L. Ponce, and J. R. Meiman.
Water Resources Bulletin, Vol. 19, No. 3, p 415-419, June, 1983. 1 Tab, 16 Ref.

Descriptors: *Water yield improvement, *Forest management, *Range management, Watershed management, Water demand, Water supply, Hydroelectric power, Vegetation management.

The demand for more water is increasing throughout the country. Research on upland watersheds clearly demonstrates that water yield can be increased using forest and range management practices. The immediate potential for water yield augmentation is on carefully selected watersheds that have the bio-physical potential to produce high value water under environmentally acceptable multiple use management. The first such watersheds to be managed in all regions are those that supply municipal-industrial water directly or contribute directly and significantly to hydropower generation. Management of these types of watersheds on any large scale will require changes in approaches to economic analysis and in water laws. The opportunity to augment water yield as a large scale program may not be as great as has been demonstrated on small experimental watersheds because of many physical and administrative constraints. There is little incentive for private landowners to manage for the production of a commodity they cannot market. The extent of water yield augmentation using vegetation management will depend on the need for additional water as well as the alternative means available to meet this need. (Moore-IVI)
W84-01926

EVALUATION OF OPERATIONAL CLOUD SEEDING PROJECTS,
Illinois State Water Survey Div., Champaign.
C.-F. Hsu, and S. A. Changnon, Jr.
Water Resources Bulletin, Vol. 19, No. 4, p 563-569, August, 1983. 3 Fig, 1 Tab, 19 Ref. NSF grants ATM 79-05007, ATM 81-07027.

Descriptors: *Cloud seeding, *Evaluation, Weather modification, Statistical methods, Hail, Snow, Rain.

Operational cloud seeding projects, those designed to produce a desired change in the weather and that are nonexperimental in nature, continue to be pursued widely in the United States. Evaluation of such projects is now recognized as having scientific benefits, and a four-year study has addressed various techniques and statistical methods to perform evaluations and to learn more about how to modify the weather. Most such evaluations hinge on some type of space-time comparisons, but valid comparisons can be obtained only by avoiding biases in the project design and operation. Factors relevant to an evaluation include choice of response variables, sampling unit, project type (rain, snow, or hail), period used for data formation, target control design, sample size (seeded and unseeded), covariates, sizes of target and control areas, assumed seeding effect (additive, multiplicative, or varying), and statistical techniques em-

ployed. Rerandomization testing is recommended for the actual evaluation of operational cloud seeding projects. Valid comparisons can be obtained only if one avoids certain obvious biases. Elements essential to better evaluations are: using uniformly defined observations for seeded and nonseeded occasions; using a uniform method in measuring response variables; selecting target control design and statistical technique a priori; adhering rigorously to a preordained protocol; and documenting the seeding operation as completely as possible, including seeding criteria used, methods of collecting and recording data, seeding agent amount and timing, instrumentation, and seeding rate. It appears that useful evaluation of operational projects can be made. (Moore-IVI)
W84-01940

3C. Use Of Water Of Impaired Quality

WASTEWATER REUSE: A RESOURCE OR A NUISANCE,
American Water Works Association Research Foundation, Denver, CO.
For primary bibliographic entry see Field 5F.
W84-01799

WATERFLOODING WILL BENEFIT SOME GAS RESERVOIRS,
Petroleos Mexicanos, Mexico City.
S. Rivas-Gomez.
World Oil, Vol. 196, No. 5, p 71-82, April, 1983. 6 Fig, 4 Tab, 6 Ref.

Descriptors: *Gas wells, *Water injection, Waterflooding, Gas reservoirs, Aquifers, Injection wells.

A method is proposed for increasing recovery from gas condensate reservoirs with retrograde condensation and high structural relief, by means of maintaining reservoir pressure above dew point through water injection. The technique is to inject water in the vicinity of the water-gas contact, or in convenient points in the bottom of the gas-bearing zone, to maintain reservoir pressure at such a level that bottomhole flowing pressure of the producing wells remains above the dew point of the fluids. The method is highly recommended where applicable since, according to a case study, expected recovery increases range from 111% to 210% for liquids and from 3.55% to 6.5% for gas. The process avoids retrograde condensation during the water injection stage and the consequent loss of a large volume of liquids. It also maintains a high reservoir pressure, reducing compression requirements. During the pressure maintenance stage, well productivities are sustained by preventing liquid accumulation in the wellbore vicinity. The reservoir should not have an active aquifer. (Moore-IVI)
W84-02050

3D. Conservation In Domestic and Municipal Use

DENVER'S WATER CONSERVATION PROGRAM,
Denver Water Dept., CO.
R. D. Wiley.
Journal of the American Water Works Association, Vol. 75, No. 7, p 320-323, July, 1983. 1 Tab, 5 Ref.

Descriptors: *Water conservation, *Water use, *Denver, Education, Information, Water reuse, Lawns, Irrigation, Municipal water, Evapotranspiration, Plumbing, Pricing.

In response to water shortages and a court decree, the Denver Water Department has undertaken a variety of programs to restrict water use during the growing season and to develop a conservation ethic among customers without imposing unreasonable lifestyle changes. The Denver potable water reuse demonstration project, scheduled for completion in 1983, is designed to determine whether potable water that is comparable in quality to Denver's existing supply can be continuously and reliably produced from secondary sewage effluent. Other water saving programs are the department's restrictions on water use in the summer months and tap allocations. The conservation program embodies a number of well-known methods of reducing water usage, including: retrofitting plumbing fixtures, plumbing code revisions, leak detection, universal metering, and conservation through rate modification. One of the most easily implemented and least controversial programs is the education and public information program. Approximately 80% of all residential water use in the Denver system goes into yard irrigation, mainly bluegrass lawns, during the summer months. The ET (evapotranspiration) program is aimed at reducing the use of water for lawn watering through the use of ET data by homeowners. (Moore-IVI)
W84-01794

CHOOSING THE OPTIMAL WATER CONSERVATION POLICY,
Policy Sciences Associates, Boulder, CO.
W. B. Lord, J. A. Chase, and L. A. Winterfield.
Journal of the American Water Works Association, Vol. 75, No. 7, p 324-329, July, 1983. 6 Tab, 6 Ref.

Descriptors: *Water conservation, *Policy making, Administrative decisions, Public policy, Colorado, Surveys, Public opinion, Colorado.

A random sample survey was made of 600 residential water users who live in three medium-sized communities along the Front Range of Colorado to study public acceptance, effectiveness and financial feasibility of various outdoor water use conservation programs. The study was specifically concerned with conservation of water used for lawn watering, because this type of use accounts for nearly half of the total residential water use in these communities. Policies that provided information about water conservation actions and their consequences or ones that provided information about the need for practicing conservation were the most acceptable to the consumers. Policies that would be more effective in achieving conservation than sole reliance on information were less widely accepted. Still, policies that rewarded consumers who took actions to conserve water and policies that included restrictions on water use that appeared to be both equitable and not too confining were acceptable to most users. Policies that penalized those who did not conserve or policies that included restrictions perceived to be inequitable, severe, or both were unacceptable to most. Conservation pricing was moderately acceptable and would be one of the more effective policies in achieving water use reductions. A substantial majority of users preferred increasing or inverted block pricing to the more common declining block pricing policy. The best combination of water conservation policies for a municipal water utility depends on the relative weights that decision makers place on the three criteria of acceptability, effectiveness, and financial feasibility. Public information is a logical component for any municipal water conservation program. Beyond that, conservation pricing deserves prime consideration for a utility emphasizing either effectiveness or financial feasibility. A utility emphasizing acceptability faces a difficult choice, because there tends to be an inverse relationship between acceptability and effectiveness. (Baker-IVI)
W84-01795

REDUCING WATER DEMAND AND WASTEWATER FLOW,
Brown and Caldwell, Walnut Creek, CA.
W. O. Maddaus, D. S. Parker, and A. J. Hunt.
Journal of the American Water Works Association, Vol. 75, No. 7, p 330-335, July, 1983. 2 Fig, 2 Tab, 6 Ref.

Descriptors: *Water conservation, *Wastewater management, *Domestic water, Water use, Toilets, Showerheads, Faucets, Infiltration, Nonstructural alternatives, California, Dublin, San Ramon, Pleasanton.

The Dublin, San Ramon, and Pleasanton areas of California are located in an inland valley. Wastewater must be exported from the valley and discharged to San Francisco Bay. Water conservation, resulting in reduced volumes of wastewater flow, is considered far more cost-effective than increasing disposal capacity. Inside residential water use of wastewater flow could be reduced by about 10% if low-flush toilets, low-flow showerheads, and low-flow lavatory faucets were installed throughout the area. Such fixtures are now required for new construction in California. Retrofitting existing homes could be accomplished with an aggressive program to make older homes more water efficient. Infiltration from overwatering of lawns, leaking plumbing, or both accounts for 15 to 30% of measured wastewater flow from homes. (Moore-IVI)
W84-01796

NONCRISIS USE OF HOUSEHOLD WATER-SAVING DEVICES,
Wisconsin Univ.-Stevens Point. Dept. of Economics and Business.
D. J. Palmini, and T. B. Shelton.
Journal of the American Water Works Association, Vol. 75, No. 7, p 336-341, July, 1983. 2 Fig, 4 Tab, 9 Ref.

Descriptors: *Water conservation, *Public opinion, Administrative decisions, Public policy, Water supply, New Jersey, East Brunswick.

In anticipation of a severe water supply shortfall that could occur within the next 20 years, a limited domestic water conservation program was undertaken in East Brunswick, N.J. The implementation of the first phase of the water master plan is described and analyzed. One important finding is the evidence that the public will cooperate with a water conservation program, even in the absence of strong external incentives such as a drought. Two thirds of the householders in the first phase of the study voluntarily installed at least one of the devices when told of the benefits to the township and of the private monetary benefits to them, along with receiving two letters from municipal officials urging their cooperation. Statistical measures of the resulting water savings were developed from field studies. It was estimated that a program of this nature would save East Brunswick an average of 18964 L of water per home each year. This figure is comparable to the savings measured in two studies in California in 1977. Water may be produced by investing in new wells, reservoirs, pipelines, and pumping and treatment plants, but utilities can also produce new water through water saving techniques. While this is not the ultimate answer to the nation's growing water supply problems, it is nevertheless both effective and cost effective. It is a strategy that should be more seriously and more widely used in the long run management of water resources. (Baker-IVI)
W84-01797

MINIMUM-FLOW PLUMBING FIXTURES,
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
R. L. Siegrist.
Journal of the American Water Works Association, Vol. 75, No. 7, p 342-347, July, 1983. 1 Fig, 3 Tab, 38 Ref.

Descriptors: *Water conservation, *Plumbing fixtures, Domestic water, Minimum-flow fixtures, Cost effectiveness.

Minimum-flow plumbing fixtures and household appliances, designed to reduce water consumption by 50 to 90%, provide comparable service, are functionally similar to conventional products, are compatible with utility systems, and are potentially cost-effective. Further development and use of the products are warranted, particularly for domestic uses. Dramatic reductions in water demand resulting from the use of minimum-flow fixtures can have a significant effect on water, wastewater, and energy services. Despite the successful use of minimum-flow plumbing fixtures, there are factors that hinder their development and widespread application. These barriers are a mixture of technical,

social, economic, and institutional factors. (Moore-IVI)
W84-01798

WATER USAGE AND THE QUANTIFICATION OF UNACCOUNTED WATER IN A UNIVERSALLY METER SUPPLY AREA,
J. H. Philips.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 4, p 325-335, August, 1983. 2 Fig, 7 Tab, 6 Ref.

Descriptors: *Leakage, *Water loss, Monitoring, Water usage, Metering, Water distribution.

The only reliable means of ascertaining leakage in a distribution system is to take the summation of the individual minimum hours consumption on a number of waste metered zones and to express this as a minimum consumption for the total area considered; or to set up a section of the distribution network fed by one service reservoir and to measure the drop on that reservoir over a period of time and select the minimum hours consumption, preferably on a holiday or non-working night, and to deduct from this any unknown metered consumption during the minimum hours. If this is done it is possible to take the remaining quantity as the leakage on the system, which should not exceed 2.25 l/house/hr. This is some 12% of the average consumption. Elimination of a quantity lower than this is likely to be uneconomic. The effect of variation of industrial and trade metering policies and municipal and water service uses on the unaccounted for percentage of the water produced at source works is also demonstrated. The need for reliable statistics obtained from accurate field data is a continuing requirement for management of a water undertaking. (Baker-IVI)
W84-01821

3E. Conservation In Industry

WATER RE-USE IN PROCESSING OF PACIFIC SHRIMP,
Castle and Cooke, Inc., San Jose, CA.
L. A. Nielsen, R. J. Price, and P. A. Carroad.
Journal of Food Science, Vol. 48, No. 4, p 1056-1060, July-August, 1983. 10 Fig, 2 Tab, 6 Ref.
NOAA grant NA80AA-D-00120.

Descriptors: *Water conservation, *Water reuse, *Food processing industry, Shrimp, Fluming, Counter current flow, Cost analysis.

A Pacific shrimp (Pandalus jordani) processing plant was instrumented to measure water usage. Water consumption in the conventional processing amounts to 25-40 gallons of potable water to produce 1 lb. of finished shrimp. A water balance was completed which identified fluming as a main user of water and subject to design improvements. Re-use of water in fluming was investigated in pilot plant simulation to evaluate alternatives to fresh flow usage. A counter current flow system was designed to reduce water usage from 264 gpm to 156 gpm with acceptable microbiological quality. An economic analysis of the impact of counter current water re-use was accomplished using the actual plant operating rate of 430 lb. of shrimp per peeler. Calculations were based on processing one million pounds in a six month season. The total annual savings as a result of the recycle modification would be between $1,400 and $4,500, depending on the municipal and sewer rates. (Moore-IVI)
W84-02048

MAKE-UP WATER TREATMENT AT THERMAL POWER PLANTS AND MULTIPLE WASTE WATER RE-USE,
For primary bibliographic entry see Field 5D.
W84-02112

3F. Conservation In Agriculture

EFFECT OF SYNTHETIC CONDITIONERS ON SOIL WATER RETENTION, HYDRAULIC CONDUCTIVITY, POROSITY AND AGGREGATION,
American Univ., Beirut (Lebanon). Dept. of Soils, Irrigation and Mechanization.
M. N. Nimah, J. Ryan, and M. A. Chaudhry.
Soil Science Society of America Journal, Vol. 47, No. 4, p 742-745, July-August, 1983. 2 Fig, 2 Tab, 17 Ref.

Descriptors: *Soil conditioners, *Soil water, *Sand, *Clays, Soil texture, Arid lands, Permeability coefficient, Soil porosity, Lebanon.

Soils of extremes in texture - either sands or clay, present problems in the use of synthetic soil conditioners in the modification of soil water relationships especially in arid regions. Hygromull (a urea formaldehyde) and Agrosil LR and Agrosil S (amorphous sodium hydrosilicates) were evaluated in the laboratory on soils of different textures. Soil samples were selected from three locations in Lebanon: Leba'a in the south; Furzol in the central Beka'a valley; and Sheia'h near Beirut on the coast. Available water content was increased by Hygromull and Agrosil LR. Saturated hydraulic conductivity of the clay soils was improved by Hygromull, while that of the sandy soil was reduced by Agrosil LR. Hygromull increased porosity of all soils but, unlike Agrosil LR, had no effect on aggregation. Agrosil S had no effect on any property studied. Hygromull has greatest potential for commercial use since it was comparatively effective with both sandy and clay soils. While Agrosil LR is likely to be of some benefit in sandy soils, the acidic S form of this material is ineffective and warrants no further testing. (Moore-IVI)
W84-01865

SOIL WATER CHANGE AS RELATED TO POSITION OF WHEAT STRAW MULCH ON THE SOIL SURFACE,
Agricultural Research Service, Akron, CO. Central Great Plains Research Station.
D. E. Smika.
Soil Science Society of America Journal, Vol. 47, No. 5, p 988-991, September-October, 1983. 3 Fig, 2 Tab, 7 Ref.

Descriptors: *Fallow, *Mulches, *Straw, *Soil water, Evaporation, Water loss, Wind, Great Plains.

A field study was conducted in the Central Great Plains to determine the effects of the position of wheat straw mulch on soil water change of a silt loam soil (a montmorillonitic, mesic Aridic Paleustoll) during three 14-month fallow periods. Treatments of 4600 kg/ha of wheat straw mulch flat on the soil surface, 3/4 flat and 1/4 standing, or 1/2 flat and 1/2 standing (normal position following standard combine harvesting) were compared with bare soil. Standing stubble was 0.46 m tall. Soil water content of one 1 cu m hydraulic lysimeter within each treatment was measured daily and changes summed for each week, and at a distance of 2 m from each side of the lysimeter a neutron depth probe was used to determine soil water content weekly except when the soil was frozen. The relationship of soil water change for each weekly period with weekly values of total precipitation, total open-pan (U.S. Weather Bureau Class A) evaporation, average daylight-hour vapor pressure deficit, average maximum air temperature, average daily air temperature, average daylight-hour air temperature, total solar radiation, and average daily wind movement, was determined by single and multiple-correlation techniques. Soil water increases were related only to precipitation events with the highest correlation resulting from the 1/2 flat 1/2 standing wheat straw position treatment. Soil water losses were best correlated with wind movement with r(2) values of 0.55, 0.41, 0.41, and 0.32 for bare soil, flat 3/4 flat-1/4 standing, and 1/2 flat-1/2 standing treatments, respectively. Soil water loss occurred from both bare soil and where the mulch was flat with winds of 0.08 M/S. When 1/4 or 1/2 of the mulch was standing, a wind of at least 0.55 M/S was needed before soil water loss occurred. Standing wheat straw does not function as a wick for loss of water from the soil. (Author's abstract)
W84-01873

EFFECT OF EXCHANGEABLE SODIUM AND GYPSUM ON SURFACE RUNOFF FROM LOESS SOIL,
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
R. Keren, I. Shainberg, H. Frenkel, and Y. Kalo.
Soil Science Society of America Journal, Vol. 47, No. 5, p 1001-1004, September-October, 1983. 4 Tab, 17 Ref.

Descriptors: *Surface runoff, *Exchangeable sodium, *Gypsum, Soil conditioners, Soil infiltration, Soil surface, Soil crust, Loess.

Surface runoff from a deep silt loam loess soil at two exchangeable sodium percentage (ESP) values (4.6 and 19.3), and the beneficial effect of industrial gypsum, were studied in field plots (of 150 sq m each) under natural rainfall conditions. The ESP of the soil was found to have a very pronounced effect on the surface runoff in spite of the fact that the final infiltration rate of the soil was affected only slightly by the ESP of the soil. The effect of ESP on the percent of surface runoff is probably through its effect on the rate of crust formation. The percent of surface runoff increase during the rainy season, for both ESP levels, because the runoff from already crusted soil was higher. However, the effect of consecutive storms depended on the degree of drying between storms. Application of industrial gypsum was found to be very effective in lowering surface runoff from the soil. Spreading the gypsum over the soil was more effective than mixing it in the upper 10 cm of soil by disk. Localization of the gypsum at the soil surface, where crust is formed, explains this effect. Gypsum application lowered the ESP of the upper 10-cm layer for both gypsum treatments. Since the ESP of the soil in both gypsum treatments was about the same, it seems that the most important factor which controlled infiltration was the electrolyte concentration in the percolating solution. (Author's abstract)
W84-01876

MATHEMATICAL MODEL FOR BORDER STRIP IRRIGATION,
G. J. Weir.
Water Resources Research, Vol. 19, No. 4, p 1011-1018, August, 1983. 5 Fig, 23 Ref.

Descriptors: *Model studies, *Irrigation, Border irrigation, Infiltration, Gravity, Water resources development, Kinematic models.

A kinematic model is developed to discuss surface irrigation when the infiltration function consists of a long-time gravity term plus a short-time capillary or sorbitivity term. The corresponding model equations are solved either exactly or numerically, and several graphical solutions are presented. Using the kinematic solution a condition is suggested for the validity of the corresponding Lewis-Milne problem, and from the shallow water or dynamic equations are suggested a condition for the validity of the kinematic solution. The central mathematical approximation in the model is the discontinuous infiltration function which assumed a linear gravity term plus a discontinuous capillary or capture term. (Baker-IVI)
W84-01894

PULSED TRICKLING EFFECTS ON SOIL MOISTURE DISTRIBUTION,
Illinois Univ. at Urbana-Champaign.
S. Mostaghimi, and J. K. Mitchell.
Water Resources Bulletin, Vol. 19, No. 4, p 605-612, August, 1983. 5 Fig, 2 Tab, 5 Ref.

Descriptors: *Trickle irrigation, *Soil water, Simulation, Mathematical models, Pulsed application, Continuous application, Runoff, Trickle emitters, Water loss, Water conservation.

Laboratory experiments were conducted to study effects of trickle emitter discharge rate on the distribution of soil moisture in a silty-clay loam soil. Both pulsed and continuous irrigation treatments were studied. A simulation model was used to evaluate the results obtained in the laboratory.

The agreement between the predicted and measured soil moisture distribution patterns was quite good. For both pulsed and continuous applications, increasing trickle discharge rate resulted in a decrease in the horizontal component and an increase in the vertical component of the wetted soil profile. Compared to the continuous treatments, pulsed applications resulted in significant reduction in water loss below the root zone. Pulsed applications rates can replace continuous small discharge rates to reduce irrigation water runoff problems on heavy soils and with restricted infiltration allow the use of larger emitter orifices to decrease potential clogging of the trickle system. (Author's abstract)
W84-01946

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

FIRST FILLING OF KIELDER RESERVOIR AND FUTURE OPERATIONAL CONSIDERATIONS,
J. A. Brady, J. M. Davis, and E. W. Douglas.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 4, p 295-312, August, 1983. 9 Fig, 4 Tab, 14 Ref.

Descriptors: *Reservoirs, Water resources development, Thermal stratification, Suspended solids, Hypolimnion, Deoxygenation, Kielder Reservoir, Iron, Manganese.

The operation of Kielder reservoir is reviewed during the first two years of filling 1981 and 1982. Kielder impounding and abstraction licences and associated water supply abstraction licences on the rivers North Tyne and Tyne are described and discussed. High concentrations of suspended soilds were present in discharges to the river North Tyne during the first five months of filling. The reservoir thermally stratified during the summer of 1981 and the hypolimnion became deoxygenated. Although only the lowest level reservoir draw-off was available through this period, the quality of water discharged to the river North Tyne was satisfactory. An installed aeration system was effective in controlling the extent of deoxygenation and restricting the formation of high iron and manganese concentrations. A discussion of future discharge regimes for hydro-electric power generation, and measures that may be taken to protect and maintain the North Tyne migratory fishers are presented. (Baker-IVI)
W84-01819

PROBLEMS OF SMALL WATER SUPPLIES,
J. H. Warden.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 4, p 313-324, August, 1983. 2 Fig, 6 Tab, 2 Ref.

Descriptors: *Water supply, *Quality control, *Rural areas, Water treatment, Disinfection, Drinking water, Rural areas, Great Britain.

There is concern all over the world in industrialized countries as well as in developing countries to improve the standards of rural water supplies. A pilot study was made of about 300 small public supplies in Great Britain to obtain some way of putting factors into perspective. Of the supplies examined the source in 9 cases was boreholes, 67 had use of reservoirs, 69 used streams, 38 springs and for 10 the source of water was undefined. Of the 300 supplies, 29 had coagulation with filtration and sometimes settlement, flows being as small as 100 cubic meters/day. In general these were manned or at least visited daily. A total of 56 works had slow sand filters, mostly of the Scottish upflow type. Some 29 supplies had pH adjustments. There were no cases of the use of ozone or chlorine dioxide and only a few places used ultraviolet irradiation for disinfection. Of all sites, 42% had no disinfection at all and the remainder used chlorination. Chlorine gas was used on 23% of the supplies, disinfection with hypochlorite solution was reported for 30%, and calcium hypochlorite tablets were used on 4%. A few of the largest works in the survey were manned on the day shift, but visits were the norm for small supplies. About 31% reported daily visiting, 27% visited two or three times per week and 42% visited weekly. Quality surveillance is the responsibility of scientific services and the frequency of quality sampling varies from weekly to every six months. However, even with the sometimes primitive simplicity with which these supplies are maintained, cases of water-borne diseases are very rare. (Baker-IVI)
W84-01820

CURRENT ISSUES AND FUTURE NEEDS IN URBAN STORM DRAINAGE,
Hydraulics Research Station, Wallingford (England).
P. J. Colyer, and B. C. Yen.
Water Research, Vol. 17, No. 9, p 1067-1071, Sept, 1983.

Descriptors: *Storm drainage, Drainage, Runoff, Rainfall-runoff relationships, Model studies, Urban drainage, Storms.

Discussions and observations made during a conference on urban storm drainage are summarized. Various phenomena have recently occurred which have produced a renewed interest on the international level in urban storm drainage. Several nationally co-ordinated research and application programs have been developed. Knowledge is needed in areas such as the temporal and spatial variations of storm rainfalls, practical and reliable routing techniques for unsteady sewer flow, and the nature of overland flow. The process of storm rainfall, surface flow, pollution entrainment and transport and unsteady flow in sewers lends itself in a particularly satisfying way to mathematical simulation. However, there are trends in both the direction toward sophisticated modelling and towards simplification. Drainage management, with its need for detailed knowledge of the hydraulic performance of existing systems under specified rainfall conditions, will probably demand computer modeling of surcharged networks. However, the computer will not meet all the needs of drainage engineers. The proper collection of data is of extreme importance along with determining what to measure and how to generalize observed results in storm water quality studies. (Baker-IVI)
W84-01909

IMPACT OF DROUGHTS AND FLOODS ON THE ENVIRONMENT,
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
M. Khublarian.
Ambio, Vol. 12, No. 2, p 78-79, 1983. 3 Fig.

Descriptors: *Droughts, *Floods, Flood control, Environmental effects, Runoff, Irrigation.

The future may be freed from the environmental, social, and economic devastation brought on by floods and droughts. Advances in research can create means and methods for actively influencing the atmospheric processes that cause these natural disasters. Although the problem of floods and droughts can be radically solved by means of runoff regulation, creating the irrigation systems and application of various irrigation methods requires massive infusions of funds. The development of reliable technological and socio-economic means of prediction and control might eliminate the need for drastic, costly measures now in use. These pro-ecological means will stress optimization of physio-geographic characteristics, river basin protection, and careful treatment of the environment. The long term goals can only be achieved through cooperative efforts and an international sharing of scientific and technological knowledge. (Baker-IVI)
W84-01968

RIVER BASIN MANAGEMENT,
Economic and Social Commission for Asia and the Pacific (UN), Bangkok (Thailand).
V. R. Pantulu.
Ambio, Vol. 12, No. 2, p 109-111, 1983. 3 Fig, 3 Ref.

Descriptors: *River basins, *Water management, International agreements, River management.

Very little information exists that could provide a basis for the formulation of universally applicable principles or arrangements for international river basin management or for sharing of waters. International river basin management ranges from marginal or no cooperation among the co-sharers to a fairly high degree of harmonious cooperation. In cases where no cooperation exists between co-sharers the principal reasons appear to be disparity in economic and technological development between cosharers; mistrust of the political intentions and objectives of neighbors; and lack of genuine international interest in encouraging regional development in the basin due to the political stance of one or more of the co-riparians. Efforts are needed to evolve relatively simple and inexpensive assessment techniques and procedures for gathering basic data; conducting studies on the effects of various types of land uses on water yield, retention and quality, under different typical situations, with the object of deriving information that could be used for planning purposes; training technicians from low-latitude countries in river basin management and regional planning; and conducting comprehensive case studies on river basin management and equitable sharing of resources in ecologically representative major river basins in different parts of the world. (Baker-IVI)
W84-01970

SUB-OPTIMAL CONSTANT-VOLUME CONTROL FOR OPEN CHANNEL NETWORKS,
Cagliari Univ. (Italy). Inst. of Electrotechnics.
G. Corriga, S. Sanna, and G. Usai.
Applied Mathematical Modelling, Vol. 7, No. 4, p 262-267, August, 1983. 10 Fig, 3 Ref.

Descriptors: *Automation, *Open channels, *Networks, Mathematical models, Gates, Canals, Simulation.

A state variable mathematical model for use in the synthesis of automatic control systems for open-channel networks is presented. The system considered here consists of n-cascaded reaches joined by control gates. The linear time invariant model consists of a controllable and observable representation where the state variables are the stored water volume variations in each reach and the control signals are the variations of the control gates opening sections. The model derives, through appropriate simplifications, from a more complex one in terms of transfer functions which was derived by linearizing the Saint-Venant equations. The problem of a linear quadratic optimal regulator is formulated in classical terms for the canal system and the constant-volume control laws obtained for the simplified model have been imposed on the complex one: such a control is therefore to be considered sub-optimal. The results of a digital simulation of the controlled system behavior indicate that the system operates with practically constant stored water volumes in each reach and that such behavior is fairly close to that of a pressure-water pipe system. (Author's abstract)
W84-01996

4B. Groundwater Management

GROUNDWATER LAWS: OPPORTUNITIES FOR MANAGEMENT AND PROTECTION,
Calhoun, Hubbard, Riddle and Cox, Savannah, GA.
W. W. Ballew, III.
Journal of the American Water Works Association, Vol. 75, No. 6, p 280-287, June, 1983. 3 Fig, 24 Ref.

Descriptors: *Water law, *Groundwater management, *Georgia, Federal jurisdiction, State jurisdiction, Legal aspects, Groundwater pollution,

Waste disposal, Water pollution control, Groundwater depletion, Permits, Hazardous materials.

Present and future protection of the nation's groundwaters depends on controlling the interrelated problems of excessive withdrawals and contamination. The existing legal authority and gaps in federal and state regulatory laws as they apply to use of aquifers underlying the state of Georgia were identified. The findings of this prototype case study could be applied in many states to coordinate and enhance groundwater protection, thus assuring the availability and safety of this natural resource. The Ground Water Use Act represents Georgia's primary groundwater protection statute. The act requires major users to obtain a permit before making withdrawals, but uses for agriculture are excluded from permit requirements. Through the Hazardous Waste Management Act and the Hazardous Waste Management Authority Act, Georgia has begun an attempt to supervise the disposal of dangerous wastes. Though Georgia has coordinated its statutes well with federal laws, the need to reach agreements with neighboring states remains. (Moore-IVI)
W84-01789

AQUIFER THERMAL ENERGY STORAGE: AN ATTEMPT TO COUNTER FREE THERMAL CONVECTION,
Auburn Univ., AL. Dept. of Civil Engineering.
F. J. Molz, J. G. Melville, O. Guven, and A. D. Parr.
Water Resources Research, Vol. 19, No. 4, p 922-930, August, 1983. 16 Fig, 3 Tab. 12 Ref. DOE subcontract B-67770-A-0.

Descriptors: *Injection wells, *Thermal energy storage, *Recovery wells, Aquifers, Geohydrology, Transmissivity, Heat conduction, Mobile, Alabama.

In an attempt to counter the detrimental effects of convection on aquifer thermal energy storage (ATES), a dual recovery well system was constructed at a Mobile (Alabama) site and an injection-storage-recovery cycle performed. Using a partially penetrating well, cycle 3-3 injection began on April 7, 1982. A total of 56,680 cu m of 79 C water was injected. After 57 days of storage, production began with a dual recovery well system. Due to the dominating effect of nonhomogeneities, the dual well system did not work particularly well, and a recovery factor of 0.42 was achieved. The degree of aquifer heterogeneity at the location of the present experiments was not apparent during previous experiments at a location only 109 m away, although pumping tests indicated similar values of transmissivity. Therefore aquifers with the same transmissivity can behave quite differently in a thermal sense. Heat conduction to the upper aquitard was a major energy loss mechanism. Water sample analyses indicated that there were no important changes in the chemical constituents during the set of experiments. There was a 19% increase in total dissolved solids. At the end of injection, the land surface near the injection well had risen 1.39 cm with respect to bench marks located 70 m away. The average elevation gradient was 0.0002. Depending on local stratigraphy, injection temperature, and injection volume, elevation changes 2 or 3 times greater than those observed at the Mobile site seem possible. (Moore-IVI)
W84-01885

LEAKY ACRES RECHARGE FACILITY: A TEN-YEAR EVALUATION,
Agricultural Research Service, Fresno, CA. Water Management Research Lab.
H. I. Nightingale, J. E. Ayars, R. L. McCormick, and D. C. Cehrs.
Water Resources Bulletin, Vol. 19, No. 3, p 429-437, June, 1983. 5 Fig, 5 Tab, 15 Ref.

Descriptors: *Groundwater recharge, *Artificial recharge, Costs, Recharge basins, Recharge rate, Turbidity, Alluvial soils, Soil surface, Storm runoff, Soil erosion, Water quality, California, Fresno, Leaky Acres Recharge Facility.

From 1971-1980, studies were conducted at the Leaky Acres Recharge Facility, Fresno, California, to identify and quantify the factors that determine the long term (10-year) effectiveness of basin type artificial ground water recharge through alluvial soils. High quality irrigation water from the Kings River was used for recharge. Construction and land costs for the present expanded facility 83 ha (205.2 ac) using three parcels of land were $1,457,100. The nine-year annual mean costs for only canal water, maintenance, and operation were $110.42/ha.m ($13.62/ac.ft) based on an average recharge rate of 1338 ha.m/yr (10,848 ac.ft/yr) at 86% facility efficiency. The measured end of season recharge rate averaged 14.97 + or - 0.24 cm/day. The 10-year mean actual recharge rate based on actual water delivered, total ponded area, and total days of recharge was 12.1 cm/day. The success of the project is related to: the low turbidity, nutrients, and salt content of the input water; permeable sandy surface soils and favorable subsurface geology that allows rapid horizontal movement of the water; good management to control the major biological factors leading to clogging of the surface soils; and cooperation between the irrigation district that delivers the water, city personnel who manage the facility, and research personnel. The major problems are related to soil erosion within the basins, and the resulting surface sealing with fine soil particles, as governed by the ground surface slopes in the borrow strip for soils used to built the levees. The continued success of this recharge project is highly dependent upon keeping turbid storm runoff water out of the basins. (Moore-IVI)
W84-01928

TEN YEARS TO SLAKE A GLOBAL THIRST,
For primary bibliographic entry see Field 6D.
W84-02011

WATERFLOODING WILL BENEFIT SOME GAS RESERVOIRS,
Petroleos Mexicanos, Mexico City.
For primary bibliographic entry see Field 3C.
W84-02050

4C. Effects On Water Of Man's Non-Water Activities

HYDROLOGY AND SOIL LOSS FROM A HIGH-FERTILITY, ROTATIONAL PASTURE PROGRAM,
Science and Education Administration, Coshocton, OH.
L. B. Owens, R. W. Van Keuren, and W. M. Edwards.
Journal of Environmental Quality, Vol. 12, No. 3, p 341-346, July-September, 1983. 2 Fig, 6 Tab, 14 Ref.

Descriptors: *Agricultural runoff, *Grazing, *Cattle, *Soil loss, Vegetation, Environmental effects, Pasture management, Precipitation, Ohio.

Five small watersheds (0.25-3.1 ha) on sloping uplands in eastern Ohio were used to evaluate environmental effects of a beef management program of rotational summer grazing on one area, and rotational winter grazing/feeding with stored hay on another area. During the 5-y study, annual precipitation was 1080 mm, which was 8-15% greater than the long-term average. The surface runoff was measured by precalibrated H-flumes, and automatically sampled using Coshocton wheels. Surface runoff from watersheds with beef cattle management increased, compared with the long-term averages when hay was grown on the watersheds. Greater precipitation was the primary factor causing more runoff during the growing season (May-October), and the cattle management was a major contributing influence on the runoff increase during the dormant season (November-April). Maintenance of good vegetative cover on the study areas was a major factor in limiting annual average surface runoff to < 110 mm, which was a relatively small amount. The large runoff events, although a small percentage of the total number of events, produced most of the runoff volume. Soil loss from these pastures was minimal. (Author's abstract)
W84-01807

4D. Watershed Protection

BURIED PIPE SYSTEM FOR CONTROLLING EROSION AND SEDIMENT LOSS ON IRRIGATED LAND,
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
For primary bibliographic entry see Field 5G.
W84-01866

SEDIMENT DEPOSITION ESTIMATION FROM CESIUM-137 MEASUREMENTS,
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W84-01938

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

LONG-CHAIN ALKYBENZENES AS MOLECULAR TRACERS OF DOMESTIC WASTES IN THE MARINE ENVIRONMENT,
Massachusetts Univ., Boston.
R. P. Eganhouse, D. L. Blumfield, and I. R. Kaplan.
Environmental Science and Technology, Vol. 17, No. 9, p 523-530, September, 1983. 6 Fig, 3 Tab, 45 Ref. DOE contract EY-76-3-03-0034.

Descriptors: *Environmental tracers, *Domestic wastes, *Municipal wastes, Linear alkylbenzenes, Surfactants, Marine environment, Marine sediments, Particulates, Alkyl benzenes, Los Angeles, California.

A suite of secondary C10-14 substituted benzenes known as linear alkylbenzenes (LABs) were found in southern California's municipal wastes. These compounds are manufactured for the production of the linear alkylbenzenesulfonate (LAS) surfactants used in commercial detergent formulations. Thus, their appearance in wastes is believed to result from incomplete sulfonation of the linear alkylbenzenes and subsequent carryover in detergents and/or by desulfonation of LAS. LABs were evaluated as waste tracers in the marine environment by determining their concentration and composition in suspended particulate matter and sediments in the vicinity of a major wastewater outfall system. They appear to be preserved in sediments for time periods of 10-20 years. A complex assemblage of surfactant-related branched alkylbenzenes was also found in the waste-affected sediments. Sedimentary distributions of both the linear and branched alkylbenzenes are discussed in terms of the historical emission of wastes in Los Angeles and surfactant usage rates. The results demonstrate that LABs are potentially useful as molecular tracers of domestic wastes and, under appropriate conditions, as geochronological tools. (Author's abstract)
W84-01780

CHLORINATED NEUTRAL ORGANICS IN BIOLOGICALLY TREATED BLEACHED KRAFT MILL EFFLUENTS,
Pulp and Paper Research Inst. of Canada, Pointe Claire (Quebec).
R. H. Voss.
Environmental Science and Technology, Vol. 17, No. 9, p 530-537, 1983. 6 Fig, 4 Tab, 59 Ref.

Descriptors: *Kraft mills, *Bleaching wastes, *Chlorinated hydrocarbons, Effluents, Pulp and paper industry, Organic compounds, Chlorine, Biological wastewater treatment, Chlorinated sulfones, Chloroform, Canada.

The occurrence of chlorinated organic material in spent liquors from the bleaching of kraft pulp is an inevitable result of the common practice of using Cl2 as a bleaching agent. Although more than 100 chlorinated organic compounds have been identified in untreated process effluents from the kraft bleaching process, far fewer chlorinated organics have been found in biologically treated combined bleached kraft mill effluent. Biologically treated combined mill effluents sampled at nine softwood bleached kraft mills located across Canada were surveyed for chlorinated neutral organic compounds. The test results showed only four main chlorinated compounds: chloroform (7-105 micro g/L), dichlorodimethyl sulfone (64-429 micro g/L), trichlorodimethyl sulfone (0.3-12.4 micro g/L), and (tentatively) tetrachlorodimethyl sulfone (0.4-1.1 micro g/L). Unlike chloroform, the chlorinated sulfones were found to be relatively resistant to removal by biological treatment in an aerated lagoon. However, preliminary assessment of fish bioaccumulation potential, acute fish toxicity, and Ames mutagenicity indicated that the chlorinated sulfones would have no immediate adverse effect on the aquatic environment. (Moore-IVI)
W84-01781

EFFECTS OF TOXIC POLLUTANTS ON INDICATOR GERMS IN LARGE-SCALE SOLID-WASTE ECOSYSTEMS,
Marburg Univ. (Germany, F.R.). Fachbereich Humanmedizin.
K. H. Knoll, H. H. Rump, and W. Schneider.
Ecotoxicology and Environmental Safety, Vol. 7, No. 5, p 463-474, October, 1983. 9 Fig, 1 Tab, 14 Ref.

Descriptors: *Bioindicators, *Hazardous materials, Wastewater treatment, Lysimeters, Bacteria, Cyanides, Phenols, Metals, Pesticides.

Small scale model landfills have various disadvantages such as wall effects, excessive heat radiation, or nonreproducible leaching effects due to inhomogeneities in the waste material. Reisolation tests were made of indicator bacteria with respect to vertical and horizontal leachate fluxes within the waste mold, carried out with the aid of large-scale lysimeters. Such investigations should provide an insight into how pathogenic bacteria behave after implanting them into various levels of already existing waste and molds. E. coli-d type 0119 from the ampoules introduced into the upper layer of lysimeter No. 2 could still be detected after 8 weeks, whereas type 0-86 had already died off after 4 weeks. Contradictory results were obtained for the bacteria within the waste in the sample bags. Out of the four bags placed into a layer at a height of about 3.5 m at various positions, after 4 weeks bacteria could be reisolated from only one. In lysimeter No. 9, for technical reasons, sample bags could only be placed into the upper layer. After 4 and 8 weeks the sample bags were recovered, and no test bacteria, either from the ampoules or from the wastes, could be reisolated. Whether or not lethal temperatures for microorganisms were reached after completion of the construction of the lysimeters could not be decided from the measured temperatures, although there would not seem to be another explanation. By increasing sampling frequency in other lysimeters, it was determined that indicator bacteria were killed off within a few days at 60 C. The following toxic pollutants had been added to the lysimeters: cyanide, phenols, galvanic sludge, and some pesticides. (Baker-IVI)
W84-01826

POPULATION ECOLOGY OF ROTIFERS AS A BIOASSAY TOOL FOR ECOTOXICOLOGICAL TESTS IN AQUATIC ENVIRONMENTS,
Frankfurt Univ. (Germany, F.R.).
U. Halbach, M. Siebert, M. Westermayer, and C. Wissel.
Ecotoxicology and Environmental Safety, Vol. 7, No. 5, p 484-513, October, 1983. 33 Fig, 23 Ref.

Descriptors: *Population dynamics, *Rotifers, *Bioassay, Water quality, Monitoring, Toxicity, Brachionus.

The population dynamics of the monogonont rotifer Brachionus rubens were used under controlled experimental conditions as a sensitive bioassay for toxic substances in sublethal doses. Even slight reductions in organism fertility and life expectancy were reflected at the integrated level of population dynamics. Serving as bioindicators for the standard test are the population parameters intrinsic rate of natural increase (r), carrying capacity (k), frequency (f), and pregnancy of the density oscillations (p). The optimal spreading power (steepest slope of the response curves) lies at different concentration areas for each parameter, so that they can be used specifically in standard tests. (Author's abstract)
W84-01827

TOTAL ALKALINITY VERSUS BUFFER VALUE (CAPACITY) AS A SENSITIVITY INDICATOR FOR FRESH WATERS RECEIVING ACID RAIN,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
S. D. Faust.
Journal of Environmental Science and Health, Vol. A18, No. 5, p 701-711, September, 1983. 2 Fig, 4 Tab, 17 Ref.

Descriptors: *Alkalinity, *Acid Rain, *Water quality, Water pollution effects, Indicators, Acidity.

The frequently stated idea that total alkalinity is a measure of the buffer capacity of a natural water is refuted. Total alkalinity is a measure of the acid neutralizing capacity, equivalents/liter, of a water. In natural waters, the carbonate system provides most of this neutralizing capacity. In as much as the pH values of natural fresh waters lie below 8.3, the total alkalinity is, for all intents and purposes, the total bicarbonate content. Any contributions of carbonate and hydroxide to total alkalinity are nil. The buffer capacity or buffer value is the relation between the increment of a strong base, or strong acid, that causes a one unit change in the pH value. The values of total alkalinity and pH, considered individually cannot give an accurate assessment of the impact of acid deposition on a natural water. Rather it is necessary to combine the pH and alkalinity values into the beta concept in order to assess accurately and to calculate the capacity of a natural water to resist the impact of acid deposition. An analytical determination of total alkalinity is given with an application of the beta value. (Baker-IVI)
W84-01860

SIMPLE DETERMINATION OF OXIME CARBAMATES IN SOIL AND ENVIRONMENTAL WATER BY HIGH PRESSURE LIQUID CHROMATOGRAPHY,
Institute for Pesticide Research, Wageningin (Netherlands).
A. Dekker, and N. W. H. Houx.
Journal of Environmental Science and Health, Vol. B18, No. 3, p 379-392, June, 1983. 2 Fig, 2 Tab, 9 Ref.

Descriptors: *Pollutant identification, *Water analysis, *Soil analysis, Aldicarb, Oxamyl, Methomyl, High pressure liquid chromatography, Chromatography.

A method is described for determining residues of aldicarb, aldicarb sulfoxide, aldoxycarb, oxamyl and methomyl in soil, groundwater and surface water. Subsoils were extracted with water and topsoils were extracted with acetone. The aqueous samples were either directly injected after acidification or concentrated by extraction with chloroform. The organic extracts were evaporated to dryness and redissolved in acidified mobile phase. The compounds were detected with a variable wavelength U.V. detector or with a fluorometric detector after a post-column reaction. Compounds within a concentration range from 0.5 ng/ml to 200 ng/ml could be determined with a maximum coefficient of variation of 7.5%. Recoveries varied from 77.0 to 98.8%. (Baker-IVI)
W84-01861

UTILITY OF ENDOTOXINS AS A SURROGATE INDICATOR IN POTABLE WATER MICROBIOLOGY,
Illinois Inst. of Tech., Chicago. Dept. of Environmental Engineering.
C. N. Haas, M. A. Meyer, M. S. Paller, and M. A. Zapkin.
Water Research, Vol. 17, No. 7, p 803-807, July, 1983. 3 Tab, 12 Ref.

Descriptors: *Water quality, *Indicators, *Endotoxins, Coliforms, Bacteria, Potable water, Spectrophotometry.

Whether the measurement of gram-negative bacterial endotoxins could serve as a useful surrogate to the measurement of either total coliforms or standard plate count organisms to determine raw water quality was investigated. The LAL spectrophotometric assay of gram-negative bacterial endotoxin was used for the study. While statistically significant associations were noted between standard plate count, membrane standard plate count and total coliform organisms and total endotoxins, these were at a relatively low coefficient of determination. In the two water treatment and distribution systems studied, endotoxins were observed at levels between 3-14 micrograms/liter. There was little advantage found in the use of the free or bound (total-free) endotoxin analysis in correlating standard bacteriological parameters, and there may be some interference of an unknown nature between the LAL spectrophotometric endotoxic analysis and particulate material present in natural surface, partially treated, and finished potable water. From a practical point of view these findings do not justify the use of the LAL spectrophotometric procedure as a surrogate or rapid measurement of these classical parameters. (Baker-IVI)
W84-01898

COMPARATIVE STUDY ON ORGANIC CONSTITUENTS IN POLLUTED AND UNPOLLUTED INLAND AQUATIC ENVIRONMENTS - V; ORGANIC CARBONS AND HYDROCARBONS IN SEDIMENTS,
Tokyo Metropolitan Univ. (Japan). Dept. of Chemistry.
G. Matsumoto.
Water Research, Vol. 17, No. 7, p 823-830, 1983. 2 Fig, 3 Tab, 23 Ref.

Descriptors: *Organic carbon, *Hydrocarbons, *Sediments, *Pollutant identification, *Sludge, *Wastewater, Japan, Tokyo, Tama River, Ogasawara Islands, Water pollution sources, Urban areas, Industrial wastes, Alkanes, Squalene.

Organic carbons and hydrocarbons were analysed for polluted sediments from Tama River and sludges from night soil and sewage treatment plants in the Tokyo area (Japan) and unpolluted sediments from river and reservoirs from Chichijima Island in the Ogasawara (Bonin) Islands to characterize their features for polluted and unpolluted aquatic environments. In addition the relationships of the features of organic consituents between waters and sediments were given. The contents of n-alkanes (C14-C36), squalane and unresolved complex mixture of hydrocarbons (UCMH) for the sediments from Tama River ranged from 16 to 94, 0.86-15 and 250-1100 micro g/g dry base, which are much higher than those of the sediments from Chichi-jima Island. The major constituents of hydrocarbons in the sediments and sludges from the Tokyo area were mainly odd-carbon numbered n-alkanes and squalene, whereas those of the island were only odd-carbon numbered n-alkanes. Hydrocarbons as carbon (total content x 0.851, as C20H42, HCC)/total organic carbon (TOC), HCC/extractable organic carbon with ethyl acetate (EOC), squalene as carbon (SqC)/TOC, SqC/EOC and UCMH/n-alkane (C15-C33) values for the sediments from Tama River were much higher than those of the sediments from the island, while carbon preference index (CPIH) values for the sediments of Tama River were considerably lower than those of the island. It was thus indicated that HCC/TOC, HCC/EOC, UCMH/n-alkane and CPIH values should be the important indicators of hydrocarbon pollution for aquatic environments. In addition SqC/TOC and SqC/EOC ratios are apparently useful measures of urban-industrial activities on

aquatic environments. The similarity of the nature of hydrocarbons of sediments and sludges from the Tokyo area indicated that the sewage contributed considerably to urban river sediments. Further it was also indicated that hydrocarbons were concentrated in sedimentary environments, although the features of hydrocarbons in sediments are generally similar to those of waters. (Author's abstract)
W84-01899

POLLUTION LEVELS IN SOME NIGERIAN RIVERS,
Ibadan Univ. (Nigeria). Dept. of Preventive and Social Medicine.
P. A. Oluwande, M. K. C. Sridhar, A. O. Bammeke, and A. O. Okubadejo.
Water Research, Vol. 17, No. 9, p 957-963, 1983. 2 Fig, 6 Tab, 22 Ref.

Descriptors: *Pollution load, *Tropical regions, *Rivers, *Nigeria, Water temperature, Wastewater, Water pollution sources, Seasonal variation, Eutrophication, Oxygen, Supersaturation, Light, Bacteria, Water quality.

Surveys of five rivers in a hot-humid zone of a tropical country (Nigeria) were carried out over 3 years by obtaining samples for physical, chemical and bacteriological analyses. The main characteristics monitored were temperature, turbidity, total, dissolved and suspended solids, pH, dissolved oxygen, BOD, ammonia-nitrogen and the coliform counts. In addition, the main characteristics of the liquid waste being discharged into the rivers were determined. During the dry season, the highest mean temperature is 29 C with a range of 5 C and the lowest is 26 C with a range of 3 C. In the wet season, the highest mean temperature is 27.3 C with a range of 2 C while the lowest is 24.5 C with a range of 1 C. The other characteristics vary more widely with seasons. The high temperature in these rivers all the year round encourages pollution by human activities. During the dry season, pollution causes prolific algae boom, which causes oxygen supersaturation during periods of high temperature and abundant sunlight. The physical, chemical and biological characteristics of the rivers deteriorate sharply as they flow through towns annd other human communities. (Author's abstract)
W84-01905

IN SITU PERISTENCE OF INDICATOR BACTERIA IN STREAMS POLLUTED WITH ACID MINE DRAINAGE,
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.
N. E. Carlson-Gunnoe, C. B. Law, and G. K. Bissonnette.
Water Research, Vol. 17, No. 9, p 1119-1124, September, 1983. 3 Fig, 3 Tab, 20 Ref.

Descriptors: *Indicators, *Bacteria, *Acid mine drainage, Monitoring, Streams, Fecal coliforms, Coliforms, Streptococci, Domestic wastes.

Persistence of indicator organisms associated with natural samples of raw sewage was studied following in situ exposure to five aquatic environments. Three of these streams contained significant amounts of acid mine water while the other two were relatively uncontaminated. Indicator organisms were rapidly killed upon exposure to the acid mine systems, whereas little reduction in numbers was noted in the uncontaminated streams. Seasonal changes affected survival of indicators as reflected by prolonged persistence at colder in situ water temperatures. The fecal coliform group was most susceptible to the acid mine water stress, while the fecal streptococci were most persistent. An enrichment technique resulted in substantially enhanced recovery of certain species of sublethally injured survivors of acid stress. Enrichment was particularly beneficial for recovery of acid mine water injured fecal coliforms. Relatively little improvement in recovery of fecal streptococci was afforded by the enrichment technique. These findings suggest that dependence on coliform analyses may not be adequate for reliable determination of bacteriological water quality in acid streams. If coliforms are to be used for reliable determination of bacteriological water quality in acid streams, it would seem essential that enrichment techniques be used in order to recover sublethally injured survivors. (Baker-IVI)
W84-01911

STABILIZED TEMPERATURE PLATFORM FURNACE WITH ZEEMAN EFFECT BACKGROUND CORRECTION FOR TRACE ANALYSIS IN WASTEWATER,
Bodenseewerk Perkin-Elmer and Co., Uberlingen (Germany, F.R.).
U. Vollkopf, A. Grobenski, and B. Welz.
Atomic Spectroscopy, Vol. 4, No. 5, p 165-170, September-October, 1983. 14 Fig, 1 Tab, 7 Ref.

Descriptors: *Trace metals, *Pollutant identification, *Wastewater analysis, Cadmium, Lead, Chromium, Zeeman effect, Stabilized temperature platform furnace.

Conventional graphite furnace atomic absorption (AA) is often plagued by nonspectral as well as spectral interferences. This is particularly true in the determination of trace metals in complex matrices like wastewater. For the elimination of nonspectral interferences, the Stabilized Temperature Platform Furnace (STPF) concept was applied. To avoid spectral interferences caused by high and structured background, the Zeeman/5000 system was used. The results of the determination of Cd, Cr, and Pb in various wastewaters demonstrate that the application of the STPF concept provides an optimum environment for atomization in a graphite furnace. All of the STPF parameters must be applied to guarantee that the majority of determinations can be carried out free from vapor-phase interferences directly against reference solutions. Matrix modification and peak area integration are important integral parts of the complete concept. The combination of the STPF with Zeeman effect background correction permits in addition the direct determination of ultratrace amounts of metals even in complex matrices where extremely high or structured background plagues conventional graphite furnace AA. (Baker-IVI)
W84-01971

ANTHROPOGENIC ZINC AND CADMIUM BURDENS IN SEDIMENTS OF SELECTED SOUTHERN ONTARIO LAKES,
Trent Univ., Peterborough (Ontario).
For primary bibliographic entry see Field 5B.
W84-01973

ZINC, MANGANESE, AND STRONTIUM IN OPERCULA AND SCALES OF BROOK TROUT (SALVELINUS FONTINALIS) AS INDICATORS OF LAKE ACIDIFICATION,
Laval Univ., Quebec. CENTREAU.
For primary bibliographic entry see Field 5C.
W84-01980

TRACE DETERMINATION OF THE ANTIHISTAMINES TRIPELENNAMINE HYDROCHLORIDE, THENYLDIAMINE HYDROCHLORIDE, AND CHLOROTHEN CITRATE IN ADMIXTURE IN ANIMAL FEED, HUMAN URINE, AND WASTEWATER BY HIGH-PRESSURE LIQUID CHROMATOGRAPHY AND USE OF A FLUORESCENCE DETECTOR,
National Center for Toxicological Research, Jefferson, AR.
H. C. Thompson, Jr., C. L. Holder, and J. R. Althaus.
Talanta, Vol. 30, No. 4, p 251-260, 1983. 4 Fig, 7 Tab, 21 Ref.

Descriptors: *Wastewater analysis, *Drugs, Chromatography, High-pressure liquid chromatography, Gas chromatography, Research facilities.

Tripelennamine hydrochloride, thenyldiamine hydrochloride, and chlorothen citrate have been used as antihistamines and for the treatment of asthma and bronchitis. Toxicological evaluation of these drugs was scheduled as part of a structure-activity relationship study of antihistamines in rats and mice, because of the paucity of such information. Prerequisite for the evaluation was the development of analytical chemical procedures to certify the concentration, homogeneity, and stability of the drugs in dosed feed, to monitor the urine of laboratory personnel to signal their possible exposure to the drugs, and to monitor the wastewater to ensure that the test agents were not discharged into the environment. A high-pressure liquid chromatographic procedure with fluorescence detection was developed for determination of the three antihistamines in admixture in animal feed, human urine, and wastewater at levels of 500, 10 and 10 ng/g, respectively. Data on the partition values and use of a silica gel column to aid in the clean-up of sample extracts from the three substrates are reported for the three test agents. Extraction efficiencies and data concerning the stability of tripelennamine hydrochloride and thenyldiamine hydrochloride in animal feed are presented. Description of a new route for synthesis of chlorothen citrate and ancillary data concerning the gas chromatographic analysis for the three drugs in admixture in animal feed at levels as low as 10 micro g/g are also reported. (Author's abstract)
W84-02002

DETERMINATION OF TRACE AMOUNTS OF PHOSPHATE IN RIVER WATER BY FLOW-INJECTION ANALYSIS,
Okayama Univ. (Japan). Dept. of Chemistry.
S. Motomizu, T. Wakimoto, and K. Toei.
Talanta, Vol. 30, No. 5, p 333-338, 1983. 12 Fig, 2 Tab, 23 Ref.

Descriptors: *Flow-injection analysis, *Phosphates, Water analysis, Spectrophotometry, Inorganic phosphates.

A flow-injection analysis system for the determination of trace amounts of phosphate in river water has been developed. The phosphate is reacted with molybdate and malachite green in acidic medium to form a green species, the absorbance of which is measured at 650 nm. A 0.00022 M malachite green solution was found to give a good compromise between sensitivity and base-line stability. When the reagent is used for phosphorus concentrations above 200 ng/ml, the complex becomes coagulative and easily adsorbed on the surface of the tubing. The effect can be prevented by addition of ethanol to the reagent. The optimal conditions are a flow rate of 2.1 ml/min and a reagent containing 250 ml of ethanol, 70 ml of concentrated sulfuric acid and 0.11 mole of molybdenum per liter. Phosphorus (as inorganic phosphate) can be determined at the level of several ng/ml in water. Analyses can be done at a rate of up to 40 per hour. (Moore-IVI)
W84-02003

SPECTROPHOTOMETRIC DETERMINATION OF MICRO AMOUNTS OF NITRITE IN WATER AND SOIL,
Shaanxi Monitoring Station of Environmental Protection, Xian (China).
Q.-F. Wu, and P.-F. Liu.
Talanta, Vol. 30, No. 5, p 374-376, 1983. 2 Fig, 3 Tab, 11 Ref.

Descriptors: *Spectrophotometry, *Nitrites, *Water analysis, Interference, Sulfide.

A spectrophotometric method for determination of micro amounts of nitrite in water and soil is based on diazotization of p-animoacetophenone followed by coupling with resorcinol in sodium carbonate/sodium acetate medium, to form a bright gold water soluble azo-dye. Foreign ions are masked with a composite EDTA-sodium hexametaphosphate reagent. The interference of sulfide can be eliminate by addition of mercuric chloride. Beer's law is obeyed up to 20 micro g of NO2(-) in 60 ml of solution and the molar absorptivity at 435 nm is 52,700 l/m/cm. The color is stable for 10 hr. Results obtained by using the proposed method for water and soil samples agree well with those obtained by the standard method. The limit of detection of nitrite by this method is 0.005 micro g/ml. (Moore-IVI)
W84-02004

DETERMINATION OF MERCURY IN WATER BY ELECTRO-DEPOSITION AND LOW-PRESSURE RING-DISCHARGE EMISSION SPECTROSCOPY,
Wyzsza Szkola Nauczycielska w Slupsku (Poland). Dept. of Physics.
H. Z. Wrembel.
Talanta, Vol. 30, No. 7, p 481- 485, 1983. 5 Fig, 8 Tab, 47 Ref. Polish Academy of Sciences grant MR-I-15.

Descriptors: *Atomic emission spectroscopy, *Electrodeposition, *Mercury, Water analysis, Seawater, Heavy metals, Spectroscopy.

The application of low-pressure ring-discharge atomic-emission spectroscopy, combined with electro-deposition on copper and platinum, to the determination of trace mercury in water has been investigated. Distilled water, artificial Baltic Sea water, artificial sea-water, and various natural waters were examined. The limit of detection was 0.004 ng/l for distilled water, and 0.03 ng/l for artificial Baltic Sea water. Better precision was obtained with the platinum electrode, and the precision was 1-4% for mercury concentrations greater than 10 ng/l. The precision was slightly worse for sea-water samples. The sensitivity and precision of the method show that it is generally applicable to assay for mercury in environmental waters. (Moore-IVI)
W84-02005

EFFECT OF ORGANIC MATTER AND COLLOIDAL PARTICLES ON THE DETERMINATION OF CHROMIUM(VI) IN NATURAL WATERS,
Kyushu Univ., Fukuoka (Japan). Radioisotope Center.
S. Osaki, T. Osaki, H. Hirashima, and Y. Takashima.
Talanta, Vol. 30, No. 7, p 523-526, 1983. 3 Tab, 19 Ref.

Descriptors: *Chromium, *Solvent extraction, *Water analysis, Organic matter, Colloids, Chromium compounds, Seawater, Interference, Natural waters.

The chromium(VI) contents of two water samples, a river water and a sea-water, were determined by means of solvent extraction with APDC (ammonium pyrrolidinedithiocarbamate) into chloroform and by co-precipitation with iron(III) hydroxide. The analytical results depended on the separation method used, possibly because of differences in the behavior of the chemical species of chromium in natural waters. Various chromium species, including simple inorganic ions, organic complexes, Cr(III) adsorbed on inorganic colloids and Cr(III) combined with organic polymers, were prepared, and their analytical characteristics were investigated. The chromium(III) species which contribute to the error of the analytical method for Cr(VI) could not be identified. Unless the main Cr(III) species present in natural waters, and their characteristics, are known, it is difficult to rule out the possibility of a large error in the determination of Cr(VI). (Moore-IVI)
W84-02006

DETERMINATION OF CHLORIDE, NITRATE, SULPHATE AND TOTAL SULPHUR IN ENVIRONMENTAL SAMPLES BY SINGLE-COLUMN ION CHROMATOGRAPHY,
Queen's Univ., Kingston (Ontario). Dept. of Chemistry.
J. A. Hern, G. K. Rutherford, and G. W. vanLoon.
Talanta, Vol. 30, No. 9, p 677-682, 1983. 4 Fig, 6 Tab, 16 Ref. DSS contract ISU80-00350.

Descriptors: *Ion chromatography, *Chlorides, *Nitrates, *Sulfates, *Sulfur, Water analysis, Rain, Wastewater analysis, Interstitial water.

Single-column ion chromatography using conductivity detection as well as an indirect ultraviolet technique was applied to the determination of Cl(-), NO3(-) and SO4(2-) in samples of rain, sewer water, and soil-pore water. Also described are two methods which allow ion chromatographic analysis of CaSO4-extractable nitrate in soils, and total sulfur in soils, marine sediments and plant tissue. Single-column ion chromatography is well suited to rapid, simultaneous analysis for anions in aqueous environmental samples. The relative simplicity and ease of operation are conducive to routine analysis, particularly with the availability of modern data-handling systems which can be directly interfaced with the detector. No interruption of operation is necessary to regenerate a suppressor column, and indirect ultraviolet detection provides lower detection limits than previously possible with conductivity measurements. Pretreatment with a lead-charged cation-exchange resin permits the analysis of samples high in SO4(2-). (Moore-IVI)
W84-02007

DETERMINATION OF CHROMIUM(VI) IN NATURAL WATERS BY THE SORPTION OF CHROMIUM-DIPHENYLCARBAZONE WITH XAD-2 RESIN,
Kyushu Univ., Fukuoka (Japan). Radioisotope Center.
S. Osaki, T. Osaki, and Y. Takashima.
Talanta, Vol. 30, No. 9, p 683-686, 1983. 3 Fig, 2 Tab, 9 Ref.

Descriptors: *Chromium, *Sorption, Water analysis, Organic matter, Natural waters, Seawater, Interference.

The sorption of the chromium(III)-diphenylcarbazone complex (Cr-DPC) with XAD-2 has been investigated, for use in the separation of Cr(VI) from Cr(III) species in natural waters. Cr-DPC is formed from the reaction of Cr(VI) with diphenylcarbazide, but Cr(III) species give no reaction in aqueous solution. The addition of sodium chloride or sodium beta-naphthalenesulfonate markedly enhances the sorption. The Cr-DPC sorbed on XAD-2 can be almost completely eluted with organic solvents, especially methanol, but about 5% of it is irreversibly sorbed and cannot be eluted. The excess of diphenylcarbazide and some of the organic matter in natural waters are also sorbed on XAD-2 but most of the this can also be eluted with methanol. Organic matter which interferes with measurement of the absorbance of Cr-DPC can almost all be removed by extraction and chloroform. By use of these techniques, Cr(VI) in seawater has been determined by the standard-addition method. Although about 50 l of sea-water are necessary for the analysis, organic and colloidal Cr(III) species do not interfere. (Author's abstract)
W84-02008

METHOD FOR RECOVERY OF ENTERIC VIRUSES FROM ESTUARINE SEDIMENTS WITH CHAOTROPIC AGENTS,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
D. A. Wait, and M. D. Sobsey.
Applied and Environmental Microbiology, Vol. 46, No. 2, p 379-385, August, 1983. 1 Fig, 6 Tab, 26 Ref. PHS grant AI17277, DOC grant NA79AA-D-00048.

Descriptors: *Chaotropes, *Enteric viruses, *Estuarine sediments, Poliovirus, Echovirus, Rotairus, Estuaries, Virus recovery.

An evaluation was made of the ability of chaotropes, low-molecular-weight ionic compounds which enhance the solubilization of hydrophobic compounds in water, to improve the recovery of enteric viruses from highly organic estuarine sediments. Chaotropic agents alone were poor eluents of polioviruses from sediment but were effective when combined with 3% beef extract. Chaotropes of lower potency, NaNO3, NaCl, and KCl, were more efficient eluents than the stronger chaotropes, guanidium hydrochloride or sodium trichloroacetate. The most effective eluent was 2 M NaNO3 in 3% beef extract at pH 5.5, which eluted 71% of sediment-associated polioviruses. Efficient concentration of the sodium nitrate-beef extract eluate by organic flocculation required the addition of the antichaotrope (NH4)2SO4 to a 2 M concentration and Cat-Floc T (Calgon, Pittsburgh, Pa.) a cationic polyelectrolyte, to a 0.01% concentration. Dialysis of the final concentrate was necessary to reduce salts to nontoxic levels before assay in cell cultures. Trials with highly organic estuarine sediment seeded with high or low numbers of poliovirus 1, echovirus 1, or rotarvirus SA-11 demonstrated the superiority of this method over two other methods currently in use. (Author's abstract)
W84-02056

FORMATION OF THE BROMINE-CONTAINING TRIHALOMETHANE IN WATER, ITS PREVENTION AND POSSIBILITY OF ELIMINATION; PART I: DETERMINATION OF BROMIDE AND IODIDE IN LOW CONCENTRATION (BILDUNG BROMHALTIGER TRIHALOMETHANE IM WASSER, IHRE VERHINDERUNG UND MOGLICHKEITEN DER ELIMINATION; I. MITT: BESTIMMUNG VON BROMID UND IODID IN SPURENKONZENTRATIONEN),
Technische Univ., Munich (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
M. Grandet, L. Weil, and K.-E. Quentin.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 2, p 66-71, 1983. 6 Fig, 4 Tab, 24 Ref.

Descriptors: *Bromide, *Iodide, *Gas chromatography, Trihalomethanes, Drinking water, Chlorination, Water treatment, Water analysis.

During oxidative treatment of drinking water (for example with chlorine), trihalomethanes are formed by the reaction between organic matter and the halogens present in water. This formation depends on the concentration of the halogens, which usually are present in microgram quantities. In order to gain an exact knowledge of the mechanism of this formation and the possibility of eliminating the haloforms it is necessary to qualitatively evaluate bromide and iodide in the microgram-range. A gas chromatographic method was developed which allows detection of 50 micro g/l bromide and 5 micro g/l iodide without concentration and 0.5 micro g/l bromide and 0.2 micro g/l iodide with sample concentration. The relatively simple procedure is based on the transformation of the halogens into 2-bromo- or 2-iodohydrine. These derivatives are extracted with ethylacetate and are determined with an electron capture detector. The different retention times between 2-bromo- and 2-iodohydrine make possible the determination of both of the halogens in one sample of water. This method is not subject to interference, which has been proven with water samples of different origin and composition. The method is recommended to be generally used for the determination of bromide and iodide in drinking water. (Moore-IVI)
W84-02065

CHEMICAL OXIDIZABILITY OF ORGANIC WATER POLLUTANTS (CHEMISCHE OXIDIERBARKEITEN ORGANISCHER WASSERINHALTSSTOFFE (ERGEBNISBERICHT)),
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
W. Janicke.
Zeitschrifte fur Wasser und Abwasser Forschung, Vol. 16, No. 3, p 85-86, 1983. 26 Ref.

Descriptors: *Pollutants, *Chemical oxygen demand, *Waste water analysis, Analytical methods, Permanganate, Dichromate, Oxidation.

About 580 mostly organic compounds from all the important classes of substances, of synthetic and natural origin, were tested for chemical oxidizability. The method using permanganate (in acid solution) and dichromate/H2SO4 (without and with Ag+ as a catalyst) were applied in accordance with standard procedures and legislative prescriptions respectively, and the results thereof were compared with published values. The dichromate with Ag+ COD method reached oxidizabilities of nearly 100% of theory with most organic substances, and proved sufficient and adequate for the ingredients of most industrial effluents. In contrast, the permanganate-COD method mostly reaches only up to 10%, often equals 0% of the theory, and is therefore of no relevance. Comparing the 3

different oxidation methods used, the tested compounds may be classified into 4 categories of oxidation efficiency. The values of oxidizability are discussed in respect to the structural groups of the tested compounds. (Author's abstract)
W84-02066

SUBMERGED WATER PLANTS AS TESTING ORGANISMS FOR POLLUTANTS (SUBMERSE WASSERPFLANZEN ALS TESTORGANISMEN FUR BELASTUNGSSTOFFE),
TUV Stuttgart e.V., Filderstadt (Germany, F.R.).Warnetechnik und Umweltschutz.
W. Nobel, T. Mayer, and A. Kohler.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 3, p 87-90, 1983. 5 Tab, 13 Ref.

Descriptors: *Aquatic plants, *Bioindicators, *Toxicity, Water pollution effects, Ammonia, Chloride, Phosphates, Boron, Marlon A, Phenols, Heavy metals.

Results of pollution experiments with submerged vascular plants under controlled conditions in the laboratory are presented as results of toxicity tests. It is possible to use submerged macrophytes as biological indicators, especially as testing organisms for water-pollutants. The following substances show toxic effects to submerged macrophytes (first significant damage) in concentrations, which are relevant to the environment: ammonium (5 mg/l NH4), boron (1 mg/l B), chloride (50 mg/l Cl), phosphate (1 mg/l PO4), and Marlon A (0.5 mg/l MBAS). At less realistic concentrations for use as environmental indicators, first significant damages are found for different phenols (cresol 0.22 mg/l, xylenol 0.24 mg/l, phenol 0.56 mg/l), whereas first significant damages for complexed heavy metals occur at concentrations of partial use (copper 0.032 mg/l Cu, zinc 0.65 mg/l Zn, cadmium 0.011 mg/l Cd, lead about 2 mg/l Pb). (Moore-IVI)
W84-02067

ONE-DIMENSIONAL THIN LAYER CHROMATOGRAPHIC SEPARATION AND FLUOROMETRIC QUANTIFICATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN WATER SAMPLES (EINDIMENSIONALE DUNNSCHICHTCHROMATOGRAPHISCHE TRENNUNG UND FLUOROMETRISCHE BESTIMMUNG VON POLYCYCLISCHEN AROMATISCHEN KOHLENWASSERSTOFFEN AUS WASSERPROBEN),
Hygiene-Inst. des Ruhrgebiet, Gelsenkirchen (Germany, F.R.).
H. Schossner, W. Falkenberg, and H. Althaus.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 4, p 132-135, 1983. 3 fig, 3 Tab, 12 Ref.

Descriptors: *Polycyclic aromatic hydrocarbons, *Thin layer chromatography, Water analysis, Drinking water, Hydrocarbons, Wastewater analysis.

According to German drinking water regulations the quantitative analysis for 6 polycyclic aromatic hydrocarbons is necessary. The polycyclic aromatic hydrocarbon include benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, benzo(k)fluoranthene, fluoranthene, and benzo(g,h,i)perlene. The method consists of the separation of these substances by means of one-dimensional thin layer chromatography and fluorescence-spectroscopic quantitative evaluation using a computing integrator (SP 4100 Spectra-Physics). Samples of drinking water, surface water and waste water can be analyzed by this method. A clean-up of the extracts can be necessary before analyzing. (Moore-IVI)
W84-02071

REDUCTION OR SUBSTITUTION OF SILVER SULFATE USING THE STANDARD METHOD FOR CHEMICAL OXYGEN DEMAND (VERMINDERUNG ODER SUBSTITUTION VON SILBERSULFAT BEI DER CSB-STANDARD-METHODE),
Goettingen Univ. (Germany, F.R.). Inst. fuer Agrikulturchemie.
M. G. Eissa.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 4, p 136-138, 1983. 3 Tab, 6 Ref.

Descriptors: *Chemical oxygen demand, *Silver sulfate, Water analysis, Wastewater analysis, Nickel sulfate, Copper oxide, Oxalic acid.

The usual standard method (DEV) for chemical oxygen demand (COD) to determine the organic constituent of water and wastewater requires 10g of silver sulfate (Ag2SO4) to be used as an oxidation catalyst. Due to the relatively high dose and the high cost of silver, tests were made to find a way to cut down on the use of silver sulfate or replacing it altogether with either nickel sulfate (NiSO4) or copper oxide (CuO). The effects of comparative methods were tested on water specimens of various origin and on oxalic acid as a monitoring substance. The application of silver sulfate could be reduced to a tenth of the usual quantity without affecting the analytical results (average deviation = 0.6%). The two substitute catalysts, Ni-sulfate and copper oxide, produced, in comparison to Ag-sulfate, similar results when the organic constituent was above 100 mg/l O2 (average deviation = 1.60%). If the COD rate was below this level, the error percentage rose, and showed a negative correlation. It is possible to make use of these oxidation catalysts in areas where the COD is less than 100 mg/l O2, as long as the results can be adjusted by correlation. (Author's abstract)
W84-02072

SIMPLE METHOD FOR DETERMINING THE CATALASE ACTIVITY IN SLUDGE, SEDIMENT, AND WATER (EIN EINFACHES VERFAHREN ZUR BESTIMMUNG DER KATALASE-AKTIVITAT IN SCHLAMMM, SEDIMENT UND WASSER),
Stadtwerke Mainz A.G. (Germany, F.R.).
U. Obst, and H. K. Frank.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 4, p 138-139, 1983. 7 Ref.

Descriptors: *Catalase activity, *Electrochemistry, *Microorganisms, Sludge, Sediments, Water analysis, Aerobic metabolism, Hydrogen peroxide.

A simple electrochemical method is presented for determining the catalase activity of the microbial aerobic metabolism in sludge, sediment, and water. After adding hydrogen peroxide to the sample (final concentration of 0.5%) the catalytically produced oxygen is measured by an electrochemical process (Karlsruher Flasche). One to 5 minutes of reaction time permit an exact measurement. Nonbiogenic decomposition of hydrogen peroxide is recorded by an inactivated sample. In examining various specimens of sludge, sediment, and water the method was reproducible and simple. Therefore an application is proposed for these purposes. (Author's abstract)
W84-02073

ANALYSIS OF PESTICIDES AND OTHER ORGANIC POLLUTANTS BY PRECONCENTRATION AND CHROMATOGRAPHIC TECHNIQUES,
Bari Univ. (Italy). Dept. of Chemistry.
A. Agostiano, M. Caselli, and M. R. Povenzano.
Water, Air and Soil Pollution, Vol. 19, No. 4, p 309-320, May 1983. 6 Fig, 6 Tab, 16 Ref.

Descriptors: *Pesticides, *Adsorption, *Tenax, *Chromatography, Gas chromatography, Thin layer chromatography, Halogenated pesticides, Carbamate pesticides, Organophosphorus pesticides, Aldrin, Water analysis.

The adsorption properties of Tenax have been studied in order to test the possibility of concentration and recovery of pollutant substances. Pesticides of various classes (chlorinated, phosphorated, carbamates, carbonates) and other organic toxicants having different volatility were employed as substances to be concentrated. They were present in water at 0.1 ppb level of concentration. Recovery was made by solvent extraction or by thermoelution. Revelation and quantitative analysis were performed by gas chromatography and by HPTLC. The effect of the flux was investigated. Tenax is the most suitable material in comparison with other tested adsorbents. Recovery is generally good except for aldrin. An apparatus for stripping and thermoelution is described that allows one to analyze water and air pollutants. Procedures have been tested for single classes of substances or a mixture of them. (Author's abstract)
W84-02120

5B. Sources Of Pollution

TRANSVERSE MIXING IN WIDE AND SHALLOW RIVER: CASE STUDY,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W84-01773

BEHAVIOR OF ORGANIC COMPOUNDS DURING INFILTRATION OF RIVER WATER TO GROUNDWATER. FIELD STUDIES,
Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland).
R. P. Schwarzenbach, W. Giger, E. Hoehn, and J. K. Schneider.
Environmental Science and Technology, Vol. 17, No. 8, p 472-478, August, 1983. 6 Fig, 3 Tab, 42 Ref.

Descriptors: *Groundwater pollution, *Infiltration, *Groundwater recharge, Organic compounds, Path of pollutants, Chlorinated hydrocarbons, Switzerland.

Two field sites in Switzerland were used to study the behavior of organic micropollutants during infiltration of river water to groundwater. Persistent organic chemicals exhibiting octanol/water partition coefficients smaller than about 5000 moved rapidly with the infiltrating river water to the groundwater, a finding in agreement with predictions from model calculations. The biological processes which were responsible for the elimination of various micropollutants such as alkylated and chlorinated benzenes, occurred predominantly within the first few meters of infiltration. Alkylated benzenes were eliminated at faster rates than 1,4-dichlorobenzene. Anaerobic conditions in the aquifer near the river hindered the biological transformation of 1,4-dichlorobenzene. Among the compounds found to be persistent under any conditions were chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. With respect to such chemicals, bank infiltration is ineffective as a first step in the treatment of river water for water supplies. Long-term field measurements are useful to gain relevant insights into the behavior of organic micropollutants in a natural river water-groundwater infiltration system and to check the general validity of conclusions drawn from laboratory investigations. (Baker-IVI)
W84-01776

ACID RAIN: A RAPIDLY SHIFTING SCENE,
B. Hileman.
Environmental Science and Technology, Vol. 17, No. 9, p 401A-405A, 1983.

Descriptors: *Acid rain, *Policy making, Administrative decisions, Political aspects, Legislation, Water pollution sources.

Some changes are noted in the concern shown by top levels of the United States government regarding the problem of acid rain. A recent government report indicates that the problem is serious enough to warrant a search for immediate solutions, that emissions of sulfur dioxide and nitrogen oxides are at least 10 times greater from human activities than arises from natural happenings, that the areas receiving the highest deposition are within and downwind of the major source regions, and that some lakes in the major receptor areas have become more acidic in the past two decades. A National Research Council report agrees that the

current increase of acidic substances in the environment cannot be arising from natural causes. The report concluded that there is no evidence for a strong nonlinearity in the relationship between long-term average emissions and deposition. The conclusion is based on analysis of historical trends, a comparison between the historical molar ratio of sulfur dioxide and nitrogen oxides in emissions to the molar ratio of sulfates and nitrates in deposition and theoretical calculations based on lab studies of the chemical reactions involved in conversion of the oxides to the sulfates and nitrates. Confidence in current mathematical models describing the movement of acid-forming pollutants over long distances is not high. Two types of models, the STEM series and air shed model, incorporate a significant number of gas phase reactions and cloud processes into an Eulerian grid calculation. But these models have not been compared with each other or with simpler schemes. (Baker-IVI)
W84-01777

EFFECT OF SOLIDS CONCENTRATION ON THE SORPTIVE PARTITIONING OF HYDROPHOBIC POLLUTANTS IN AQUATIC SYSTEMS,
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
T. C. Voice, C. P. Rice, and W. J. Weber, Jr.
Environmental Science and Technology, Vol. 17, No. 9, p 513-517, 1983. 6 Fig, 2 Tab, 15 Ref.

Descriptors: *Partition coefficients, *Organic compounds, Water pollution, Fate of pollutants, Particulates, Organic carbon, Sediments, Lake Michigan, Chlorinated hydrocarbons, Naphthalene, Sorption.

Partition coefficients are commonly used to quantify the distribution of organic pollutants between the aqueous and particulate phases of natural aquatic systems. The magnitude of the partition coefficient for a specific pollutant in a particular system has been shown to be related to the octanol-water partition coefficient of the pollutant and the organic carbon content of the solid phase onto which sorption occurs. A third variable is important - the concentration of the sorbing solid phase in the system. Laboratory partitioning experiments were performed over a range of solids concentrations by using three different Lake Michigan sediment samples as sorbents and four hydrophobic priority pollutants (chlorobenzene, naphthalene, 2,5,2'-trichlorobiphenyl, and 2,4,5,2',4',5'-hexachlorobiphenyl) as sorbates. There is a significant increase in partitioning as solids concentration decreases. Partition coefficients developed at one concentration of solids are not necessarily appropriate at other solids concentrations, and partition coefficients produced in studies using different techniques are not necessarily comparable. The solids effect is likely to occur in the environment although the extent of the effect relative to that observed in the laboratory is unknown. (Moore-IVI)
W84-01779

SOURCE CONTRIBUTIONS TO ACID PRECIPITATION IN TEXAS,
Texas Univ. at Austin. Environmental Health Engineering Group.
J. A. Feeley, and H. M. Liljestrand.
Atmospheric Environment, Vol. 17, No. 4, p 807-814, 1983. 2 Fig, 3 Tab, 23 Ref.

Descriptors: *Precipitation, *Acid rain, *Texas, Austin, Prairie View, Highlands, Alkalinity, Ammonia, Sulfuric acid, Spatial distribution, Salts.

Wet-precipitation-only sampling at Austin, Prairie View and Highlands, Texas, has been conducted in 1980-81 to characterize sources of acid rain chemical composition. These results are compared with those of previous investigators to identify spatial distributions of source contributions. A chemical mass balance model is used to determine the spatial distributions of background crustal source alkalinity and sea salt contributions. Moisture from the Gulf of Mexico influences all three sites, as confirmed by bivariate analysis. Ammonia gas from biogenic/agricultural sources is found to be a poor buffer against further acidification in areas of local acid emissions. There is a spatial distribution in background alkalinity from soil dust sources, with a 40 micro equiv/l alkalinity contribution to east Texas precipitation. Sulfuric acid is the predominant acid and shows a significant gradient away from coastal sources. (Moore-IVI)
W84-01783

TEMPORAL VARIATIONS IN ACID PRECIPITATION OVER NEW YORK STATE-WHAT THE 1965-1979 USGS DATA REVEAL,
Consolidation Coal Co., Pittsburgh, PA.
R. A. Bilonick, and D. G. Nichols.
Atmospheric Environment, Vol. 17, No. 6, p 1063-1072, 1983. 4 Fig, 3 Tab, 10 Ref.

Descriptors: *Acid rain, *Precipitation, *Statistical analysis, Temporal distribution, Hydrogen ion concentration, Sulfates, Nitrates, Calcium, Conductivity, Ion balance.

During the period from 1965 to 1979, the USGS collected rainfall samples throughout New York State. pH, sulfate, nitrate and calcium levels were measured, among other species. The statistical nature of the variation of these quantities with time was examined in this study. A preliminary step involved using ion balances and electrical conductivities to remove inconsistent measurements, which successfully reduced the amount of noise in the data. The time series analysis method of Box and Jenkins was applied: the results indicate that the long-term mean levels of hydrogen, sulfate, nitrate and calcium ion in the bulk (wet plus dry) precipitation samples were essentially constant. Use of the Box-Jenkins method was appropriate because samples that were collected close together in time were clearly more alike than those far apart, indicating autocorrelation. An analysis that fails to take this dependency into account could lead to incorrect conclusions. (Author's abstract)
W84-01784

ACID CLOUDS AND PRECIPITATION IN EASTERN COLORADO,
National Oceanic and Atmospheric Administration, Boulder, CO. Office of Weather Research and Modification.
C. T. Nagamoto, F. Parungo, R. Reinking, R. Pueschel, and T. Gerish.
Atmospheric Environment, Vol. 17, No. 6, p 1073-1082, 1983. 7 Fig, 3 Tab, 10 Ref.

Descriptors: *Clouds, *Acid rain, *Acid precipitation, Weather patterns, Snow. Hydrogen ion concentration, Seasonal variatic olorado, Denver.

Rain and snow samples were collected at the eastern foothills of the Rocky Mountains and analyzed for chemical composition. Many precipitation samples had pH values considerably more acidic than the 5.6 value of pure water containing only an equilibrium amount of atmospheric CO2. The averages of pH for rain and snow are 4.8 and 5.5, respectively. Approximately 80% of the snow samples show pH $>$ 5.5. Clear and considerable dependencies of the acidity on seasonal synoptic scale weather patterns are demonstrated. The most acidic snow or rain in winter is prefrontal or frontal precipitation derived from deep low-pressure centers tracking across or just to the south of Colorado. The most acidic summer precipitation occurs with patterns similar to these but weaker, and with synoptic conditions conducive to isolated but relatively deep convection. Cloud water samples, collected by aircraft over eastern Colorado, also showed low pH values. The acidity of clouds was greatest near the city of Denver. Samples collected over east Denver showed pH = 3.3, indicating that the city is a major source of the acid clouds in the area. Organic anions appeared in the samples taken near the city, but not in remote samples. (Moore-IVI)
W84-01785

MOVEMENT OF TYPHOID ORGANISMS IN SATURATED PERMEABLE SOIL,
Washington Univ., Seattle. School of Public Health and Community Medicine.
J. A. McGinnis, and F. DeWalle.
Journal of the American Water Works Association, Vol. 75, No. 6, p 266-271, June, 1983. 2 Fig, 3 Tab, 48 Ref.

Descriptors: *Typhoid fever, *Groundwater pollution, *Shallow wells, Septic tanks, Salmonella, Soil porosity, Saturated soils, Public health, Groundwater movement, Water table, Drinking water, Yakima, Washington.

An outbreak of typhoid fever occurred during May 1972 in Yakima County, Washington, involving groundwater transmission of Salmonella typhi between a septic tank and a nearby shallow well. The distance between the septic tank and the well was 64 m, greater that the 30-m separation considered safe sanitary practice for septic tank design in the state of Washington. Individual soil characteristics, the direction of groundwater flow, and the velocity of groundwater flow should be considered in planning a shallow well located down the hydrologic gradient from a leach field. In a high porosity soil, a 30-m separation is probably unsafe. Where highly porous soils and fluctuating water tables provide poor filtration of sewage effluent, as in the rural setting of the town of Yakima, chlorinated community potable water systems are safer than unchlorinated individual wells. (Moore-IVI)
W84-01787

ENVIRONMENTAL STUDIES OF ENTERIC BACTERIA LONGEVITY IN MEMBRANE FILTER CHAMBERS,
National Water Research Inst., Burlington (Ontario). Analytical Methods Div.
For primary bibliographic entry see Field 5D.
W84-01804

HERBICIDE RUNOFF FROM EXPERIMENTAL WATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
T. L. Wu, D. L. Correll, and H. E. H. Remenapp.
Journal of Environmental Quality, Vol. 12, No. 3, p 330-336, July-September, 1983. 4 Fig, 4 Tab, 19 Ref. EPA grant R804536-01.

Descriptors: *Atrazine, *Alachlor, *Herbicides, *Water pollution sources, Nonpoint pollution sources, Path of pollutants, Agricultural runoff, Agricultural watersheds, Pesticide residues, Rhode River Watershed, Maryland.

Two commonly used herbicides in corn fields of the Rhode River Watershed (Maryland) were atrazine (2-chloro-4-ethylamino-6-iso-propylamino-1,3,5-triazine) and alachlor (2-chloro-2',6'-diethyl-N-methoxymethyl acetanilide). Although alachlor was applied in larger quantities, atrazine was detected more frequently in runoff waters and had greater concentrations than alachlor (0-4 micro g/L vs. 0-6 micro g/L). Atrazine was more persistent and more mobile in watershed soils. Linear regression analysis of herbicide loading rates and percentage agricultural landuse did not give a direct relationship. Runoff waters from forest watersheds where herbicides were not directly applied, were contaminated with herbicides. During the 3-y study period (1976-1978), a maximum of 10 micro g/L of atrazine, and up to 0.5 micro g/L alachlor were discharged in winter runoff waters from the eight experimental watersheds. In addition to quantity of herbicides directly applied to land surface, residual levels in runoff waters must be influenced by other important factors such as topography, location of croplands in relationship to drainage channel, etc. A major portion of atrazine was found in dissolved aqueous form in runoff-water samples collected during storm events. Percolation in subsurface flow and dissolution in overland flow were believed to be important transport mechanisms. (Author's abstract)
W84-01806

HYDROLOGY AND SOIL LOSS FROM A HIGH-FERTILITY, ROTATIONAL PASTURE PROGRAM,
Science and Education Administration, Coshocton, OH.

For primary bibliographic entry see Field 4C.
W84-01807

NITROGEN LOSS FROM A HIGH-FERTILITY, ROTATIONAL PASTURE PROGRAM,
Science and Education Administration, Coshocton, OH.
L. B. Owens, R. W. Van Keuren, and W. M. Edwards.
Journal of Environmental Quality, Vol. 12, No. 3, p 346-350, July-September, 1983. 3 Fig, 5 Tab, 17 Ref.

Descriptors: *Grazing, *Pasture management, *Water pollution sources, *Cattle, Agricultural runoff, Agricultural watersheds, Nonpoint pollution sources, Storm seepage, Nitrogen, Fertilizers, Nitrates, Ohio.

A beef cattle-pasturing system involving four rotationally grazed summer pastures (SG) and four pastures used rotationally for winter grazing/feeding (WGF) was studied on sloping upland watersheds in Ohio to determine effects of livestock management on N levels in water. Both summer and winter areas annually received 224 kg N/ha as NH4NO3 fertilizer. Surface runoff was collected automatically during runoff events, and subsurface flow was sampled from spring developments on a weekly basis. Although seasonal N concentration and transport in surface runoff tended to be greater in the area occupied by the cattle, N concentration and transport in runoff from the two areas were quite similar and did not significantly impair water quality, based on U.S. Public Health Standards. The NO3-N concentration in the subsurface flow from the WGF area was higher than in the subsurface flow from the SG area. The NO3-N concentration in the subsurface flow from both areas increased progressively throughout the study period, and reached levels as high as 18 mg/L. The subsurface flow provided the main pathway for N transport, with the surface transport being approximately 20 and 14% of the total N transport from the SG and WGF areas, respectively. The amount of sediment-N transported was very small because of low soil loss. (Author's abstract)
W84-01808

STREAM WATER QUALITY OF TWO SMALL WATERSHEDS AS AFFECTED BY SURFACE COAL MINING,
Ohio Agricultural Research and Development Center, Wooster.
W. A. Dick, J. V. Bonta, F. Haghiri, and J. R. Page.
Journal of Environmental Quality, Vol. 12, No. 3, p 351-358, July-September, 1983. 5 Fig, 8 Tab, 16 Ref. BM contracts J0166054 and J0166055.

Descriptors: *Coal mines, *Strip mines, *Water pollution sources, Water quality, Land reclamation, Suspended solids, Manganese, Hydrogen ion concentration, Flow rate, Heavy metals, Ohio.

Two small watersheds in eastcentral Ohio were selected for investigation of stream water quality prior to, during, and after surface coal mining and reclamation. Watershed C06 contained sandstone and shale overburden, and Watershed M09 contained limestone, sandstone, and shale. Water quality was monitored by measuring 39 parameters in the stream-water samples collected. Duration curves for the four parameters regulated by the Office of Surface Mining (OSM) showed that most samples collected from the two study watersheds exceeded the 70 mg/L regulation level for suspended solids concentration. Approximately 50 and 30% of the water samples collected at Watershed C06 during the mining and reclamation period and the post-reclamation period, respectively, exceeded the regulation level (4000 micro g/L) for manganese (MN). Twenty percent of the pH values at Watershed C06 during the mining and reclamation period were also below the lower regulation level (pH 6). Concentrations of the major cations and anions, suspended solids, and dissolved solids were correlated with flow rate (log values) during the premine and post-reclamation periods. Samples collected at similar flow rates at Watershed M09 showed concentrations of parameters were either not significantly affected or decreased in the post-reclamation samples, compared with the premine samples. A similar comparison for samples collected at the C06 watershed showed parameter concentrations were generally higher during the post-reclamation period. Parameters which were not detected in any samples collected from the two watersheds were arsenic (As), chromium (Cr) VI, mercury (Hg), and sulfide (S(2-)), while cyanide (CN(-)) was not detected at M09. Parameters that were only rarely detected were antimony (Sb), cadmium (Cd), lead (Pb), zinc (Zn), silver (Ag), copper (Cu), phenols, and phosphorus (P). (Author's abstract)
W84-01809

PCB PARTITIONING IN SEDIMENT-WATER SYSTEMS: THE EFFECT OF SEDIMENT CONCENTRATION,
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
L. M. Horzempa, and D. M. Di Toro.
Journal of Environmental Quality, Vol. 12, No. 3, p 373-380, July-September, 1983. 12 Fig, 3 Tab, 24 Ref.

Descriptors: *Polychlorinated biphenyls, *Sediments, *Sorption, Montmorillonite, Partition coefficients, Adsorption isotherms, Fate of pollutants, Lake sediments, Suspended particulates, Saginaw Bay, Michigan.

The effect of sediment concentration variations on polychlorinated biphenyl (PCB) sorption to natural lake sediment (Saginaw Bay, Mich.) and montmorillonite clay has been investigated. In studies utilizing tritiated 2,4,5,2',4',5'hexachlorobiphenyl (HCBP), partition coefficient values for adsorption isotherms (pi) were found to increase as sediment concentrations (m) were decreased from m = 1000 mg/L to m = 50 mg/L. HCBP adsorption to montmorillonite (m = 1000 mg/L, pi = 2900 L/kg; m = 50 mg/L, pi = 10 600 L/kg) appeared to be more sensitive to sediment concentration than did adsorption to the Saginaw Bay sediment (m = 1000 mg/L, pi = 9900 L/kg; m = 50 mg/L, pi = 17,100 L/kg). Evidence suggests that these variations are not the result of nonlinear isotherms. Although variations in solution chemical composition and kinetic effects were found to affect partitioning, neither factor appeared to adequately account for the magnitude of the observed sediment concentration effect. In experiments in which sediment concentrations were decreased (m = 1000 mg/L to 10 mg/L) while equilibrium aqueous HCBP concentrations were maintained at approximately constant levels, pi values for adsorption increased. The behavior was in conformity with the isotherm results. The observed behavior might be due to direct solid phase interactions between suspended particles. The occurrence of such interactions in natural waters could have potentially significant implications for efforts to predict sediment-water PCB distributions. (Author's abstract)
W84-01811

LOSS OF FALL-APPLIED 2,4-D IN SPRING RUNOFF FROM A SMALL AGRICULTURAL WATERSHED,
Department of Agriculture, Swift Current (Saskatchewan). Research Station.
W. Nicholaichuk, and R. Grover.
Journal of Environmental Quality, Vol. 12, No. 3, p 412-414, July-September, 1983. 1 Tab, 11 Ref.

Descriptors: *Herbicides, *Snowmelt, *Agricultural runoff, Surface runoff, Water pollution sources, Nonpoint pollution sources, Pesticide residues, Wheat, Saskatchewan.

The loss of 2,4-D (2,4-dichlorophenoxyacetic acid) applied in fall to wheat (Triticum aestivum L.) stubble on fields of Wood Mountain loam soil in semiarid southwestern Saskatchewan was measured in surface runoff from snow. The range of runoff volumes over the 6-y period was representative of runoff observed over a 30-y period at the same location. The loss of 2,4-D was greater from the treated stubble compared with fallow, which served as the control. The average loss from the control of 1.3 g/ha gives an indication of background limits that can be expected if 2,4-D is applied a year earlier. The 2,4-D loss in snowmelt runoff is similar to losses in rainfall runoff from a severe storm soon after application. The 6-y average loss was 4.1% of the amount applied (0.42 kg/ha). Correlation analysis showed that amount of loss to be a function of runoff. The average flow-weighted mean concentration of 31 micro g/L was well below the USEPA maximum permissible level of 100 micro g/L, and slightly above the U.S. National Academy of Sciences and National Academy of Engineering objective of 20 micro g/L for drinking-water standards. (Author's abstract)
W84-01812

SEAGULL POLLUTION OF RESERVOIRS,
Strathclyde Regional Council, Glasgow (Scotland). Water Dept.
C. Benton.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 4, p 347-363, August, 1983. 6 Fig, 4 Tab, 30 Ref.

Descriptors: *Reservoirs, *Water pollution sources, *Seagulls, *Bacteria, Feces, Salmonella, Water pollution control, Chlorination, Scotland, Strathclyde.

Microbiological surveys of untreated water in service reservoirs in Strathclyde Regions in Scotland revealed a deterioration in bacterial quality during storage. In a three-year study the service reservoirs supplying Loch Katrine water to Glasgow were shown to be contaminated by gulls (Larus sp) nocturnally roosting on the reservoirs in winter. Significant correlations were made between the number of roosting gulls and the numbers of E. coli present in the untreated reservoir water. In addition, similar salmonellae organisms of identical serotypes were isolated from the gulls, the untreated water and, on three occasions, from the treated water. Occlusion of bacteria by particulate avian fecal matter rendered marginal chlorination of up to 0.2 ml/l of free chlorine residual ineffective. Subsequently, the routine broadcasting by loud speaker of species specific distress calls of Larus gulls proved to be effective in discouraging gulls from roosting on the reservoirs. The disappearance of the gulls resulted in improved water quality. Water in the reservoirs at Helensburgh was also found to suffer deterioration in bacterial quality during storage. These reservoirs were studied over a three-month period to compare the effect of diurnal and nocturnal gull populations on water quality. Limited scaring was attempted at this site, and the results showed favorable improvements in water quality. (Baker-IVI)
W84-01823

POLYCHLORINATED BIPHENYL POLLUTION FROM SHIPBUILDING IN NAGASAKI BAY, JAPAN,
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
K. Maruyama, M. Sahrul, S. Tanabe, and R. Tatsukawa.
Ecotoxicology and Environmental Safety, Vol. 7, No. 5, p 514-520, October, 1983. 3 Fig, 3 Tab, 8 Ref.

Descriptors: *Polychlorinated biphenyls, *Bays, *Industrial wastes, Ships, Water pollution sources, Bioaccumulation, Japan, Nagasaki Bay.

Polychlorinated biphenyl (PCB) concentrations were determined in sediment, in water, and in biological samples from Nagasaki Bay, Japan. PCBs were detected in all samples, with highest concentrations more than 10 micrograms/g, being found in three sediment samples located near the shipyard drains. In general, PCB concentrations in sediments and organisms tended to increase toward the inner part of this bay. PCB isomer and congener compositions in organisms as well as sediments were composed mainly of higher chlorinated biphenyls and almost similar to Kanechlor 500 and 600 products (chlorine content 54 and 60%, respectively) that have been used for ship paints. These results strongly suggest that shipbuilding is primarily responsible for the PCB pollution in Na-

gasaki Bay. Bioaccumulation factors of PCBs were different among the organisms according to their trophic levels. This might be a result of the predominant PCB transfer through the food chain in organisms and the discharge of bioaccumulative PCBs as higher chlorinated biphenyls from shipyards. The PCB pollution from shipbuilding may continue for a long time due to the accumulative characteristics of PCBs used for ship paints and the further discharge by scraping the old paints in shipyards. (Baker-IVI)
W84-01828

CONCENTRATIONS AND SPECIATION OF LEAD, ZINC, AND CADMIUM IN SEAWATER-LIKE SMELTER EFFLUENT AND ADJACENT MARINE ENVIRONMENTS, PORT PIRIE, SOUTH AUSTRALIA,
Commonwealth Scientific and Industrial Research Organization, Parkes (Australia). Baas Becking Geobiological Lab.
J. Ferguson.
Australian Journal of Marine and Freshwater Research, Vol. 34, No. 3, p 375-385, 1983. 3 Fig, 5 Tab, 9 Ref.

Descriptors: *Tidal channels, *Metals, *Metal-finishing wastes, Marine environment, Industrial waster, Lead, Zinc, Cadmium.

High concentrations of particulate and dissolved lead, zinc and cadmium (total dissolved Pb, 750 micrograms/liter; Zn, 4300 micrograms/liter; Cd, 64 micrograms/liter; particulate Pb, 236 micrograms/liter; Zn 64 micrograms/liter; Cd < 1 micrograms/ liter) occur in seawater-like effluent from a lead-zinc smelting complex at Port Pirie. This effluent is discharged through a silled tidal channel into the offshore marine environment, where dilution by seawater eventually reduces the metal concentrations to values similar to those in near-surface seawater in Spencer Gulf, remote from centers of industrial activity (average total dissolved Pb, 0.4 micrograms/liter; Zn, < 10 micrograms/liter; Cd, 0.3 micrograms/liter; average particulate Pb, < 0.05 micrograms/liter; Zn, 0.2 micrograms/liter). Precipitation of dissolved metals or conversion of originally weakly complexed dissolved metals to more strongly complexed species does not occur to a significant extent. Particulate metal concentrations are influenced by resuspension of metal-rich sediments and by uptake of dissolved cadmium by unicellular algae that grow in the tidal channel. (Author's abstract)
W84-01838

THEORETICAL EXPLANATION OF SOLUTE DISPERSION IN SATURATED POROUS MEDIA AT THE DARCY SCALE,
Indiana Univ. at Bloomington. Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W84-01887

EXTENT OF REVERSIBILITY OF POLYCHLORINATED BIPHENYL ADSORPTION,
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
L. M. Horzempa, and D. M. Di Toro.
Water Research, Vol. 17, No. 8, p 851-859, 1983. 9 Fig, 4 Tab, 24 Ref. EPA grants CR805229, CR807853.

Descriptors: *Polychlorinated biphenyls, *Adsorption, *Desorption, *Lake sediments, Fate of pollutants, Montmorillonite, Kaolinite, Clay, Isotherms, Hexacholorobiphenyl, Partition coefficients, Sediments, Michigan, Lake Huron, Saginaw Bay.

The extent of reversibility of PCB (polychlorinated biphenyl) bonding to sediments has been characterized in studies on the partitioning behavior of a hexachlorobiphenyl isomer. Linear non-singular isotherms have been observed for the adsorption and desorption of 2,4,5,2'4',5' hexachlorobiphenyl (HCBP) to 1100 ppm sediment suspensions. Partition coefficients, pi(1/kg), for desorption from lake sediments (Saginaw Bay, Lake Huron, Michigan) are substantially greater (pi sub d about 20,000-35,000) than those obtained for adsorption (pi sub a about 9000-14000). HCBP was found to be more weakly adsorbed to montmorillonite (pi sub a about 3000, pi sub d about 9000) and kaolinite (pi sub a about 1000, pi sub d about 3000) clay samples than to the natural sediment samples. Desorption results (pi sub d) for Saginaw Bay sediments were quite similar to pi values (15,000-35,000) calculated from field measurements of aqueous and particulate PCB concentrations. For Saginaw Bay sediments and clay minerals partitioning appeared to be correlated both to sediment surface area and to sediment organic content. A regression analysis using both of these variables explained approximately 90% of the observed variations. HCBP adsorption at 40 degrees C (pi sub a about 14,000) was significantly greater than at 1 degree C (pi sub a about 6500) resulting in a calculated enthalpy of adsorption of +3.3 kcal/mol. Non-singular isotherm behavior was not found to be readily attributable to microbiological, kinetic or experimental effects. Evidence from consecutive desorption studies suggests that while HCBP adsorption may ultimately be reversible, release from sediments appeared to involve desorption along two distinct isotherms. These results have been interpreted in terms of possible similarities between the sorption properties observed in the distilled water systems of the present study and PCB bonding processes in natural water systems. (Author's abstract)
W84-01901

STREAM WASTE ASSIMILATIVE CAPACITY ANALYSIS USING REAERATION COEFFICIENTS MEASURED BY TRACER TECHNIQUES,
Hawaii Univ., Honolulu. Dept. of Civil Engineering.
C. C. K. Liu, and Y-S. Fok.
Water Resources Bulletin, Vol. 19, No. 3, p 439-445, June, 1983. 6 Fig, 4 Tab, 19 Ref.

Descriptors: *Assimilative capacity, *Reaeration, *Gas tracers, Tracers, Aeration, Water quality, Model studies, Canandaiqua Outlet, New York.

Atmospheric reaeration is one of the most important natural processes which determine the waste assimilative capacity of a receiving water. Values of reaeration coefficient used in the receiving water modeling analysis strongly influence the allowable wastewater treatment levels of potential point sources discharging into this water. Stream water quality models are developed with reaeration coefficients (K2) estimated by predictive equations, which leads to uncertainties in modeling analysis because these equations are empirical in nature and may yield greatly different K2 values for the same stream. The validity of a stream model would be enhanced significantly if K2 could be determined directly and reliably. Values of K2 in the Canandaiqua Outlet in Central New York have been measured by using a gas tracer method. A successful modeling analysis was conducted using these K2 values. As a result, effluent limitations of several waste water discharges into the Outlet were established. Field measurements of reaeration rate would improve modeling results significantly, and the gas tracer method can be easily incorporated into intensive water quality surveys normally required for stream modeling. (Moore-IVI)
W84-01929

DYNAMIC BACTERIAL MODEL FOR A RECREATIONAL LAKE,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Sciences.
C. G. Uchrin, and W. J. Weber, Jr.
Water Resources Bulletin, Vol. 19, No. 4, p 581-584, August, 1983. 5 Fig, 7 Ref.

Descriptors: *Bacteria, *Water pollution sources, *Fate of pollutants, Mathematical models, Simulation, Storm runoff, Wastewater, Reservoirs, Nonpoint source pollution, Ford Lake, Michigan.

A dynamic mathematical model was constructed to examine bacterial contamination problems affecting Ford Lake, a small recreational lake in Southeast Michigan. Ford Lake is a Huron River impoundment resulting from backwater caused by Ford Dam. The model was calibrated and verified using summer dry weather averaged data and data from three wet weather surveys. Model simulations demonstrated that the major bacterial contamination was attributable to storm related perturbations affecting two point sources: the Huron River and the Ypsilanti Sewage Treatment Plan. The nonpoint source contribution was relatively minor. Ford Lake serves as an effective bacteriological sink for pollutant loadings from point and nonpoint source inputs. Most of the resultant stress is confined to the upstream segments of the lake. The lake generally reverts to dry weather, steady state conditions within a week. Even under worst cases the lake exhibits negligible bacterial impact downstream. The model is currently being used by the State of Michigan Department of Natural Resources as a management tool by assessing the effectiveness of planned pollution abatement strategies. (Moore-IVI)
W84-01943

MODELING GROUND-WATER FLOW AT LOVE CANAL, NEW YORK,
GeoTrans, Inc., Reston, VA.
J. W. Mercer, L. R. Silka, and C. R. Faust.
Journal of Environmental Engineering, Vol. 109, No. 4, p 924-942, August, 1983. 7 Fig, 3 Tab, 17 Ref.

Descriptors: *Groundwater movement, *Path of pollutants, *Love Canal, New York, Geohydrology, Computer models, Lockport Dolomite, Interceptor wells, Water pollution control, Groundwater pollution.

A ground-water modeling study was conducted at the Love Canal area, Niagara Falls, New York, as part of a comprehensive evaluation of contamination at the area. The hydrogeology underlying Love Canal consists of a shallow system of silts and fine sands, underlain by confining layers of lacustrine clays and glacial till, which are underlain by the Lockport Dolomite. A two-dimensional computer model of the Lockport Dolomite was constructed to help define the ground-water flow system. Both history matching and a sensitivity analysis were conducted. Assuming the dolomite was contaminated, Monte Carlo simulation and uncertainty analysis were used to estimate contaminant travel times to the upper Niagara River. Results indicate that travel times would average 1,000 days with less than 5% probability of less than 100 days or greater than 10,000 days. Analysis of remedial action for the Lockport Dolomite using best estimates of hydrologic parameters indicates that three interceptor wells at the south end of the canal, pumped at only 1,155 cu ft/day (32.3 cu m/day), should reverse the flow of ground water to the river and provide an adequate barrier to migration of potential contaminants to the river. (Author's abstract)
W84-01956

ANTHROPOGENIC ZINC AND CADMIUM BURDENS IN SEDIMENTS OF SELECTED SOUTHERN ONTARIO LAKES,
Trent Univ., Peterborough (Ontario).
H. E. Evans, P. J. Smith, and P. J. Dillon.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 5, p 570-579, May, 1983. 3 Fig, 4 Tab, 44 Ref.

Descriptors: *Cadmium, *Zinc, *Lake sediments, Lead, Heavy metals, Water pollution sources, Watershed area, Replenishment, Atmosphere, Ontario.

The concentrations of Cd and Zn were measured in the sediments of 10 softwater lakes in southern Ontario. Elevated Cd and Zn levels were present in the recently deposited sediments of all the lakes, despite the absence of local point-source inputs. Whole-lake anthropogenic Zn and Cd burdens, calculated by prorating site-specific burdens according to the ratio of the site-specific Pb burden to the whole-lake Pb burden, range between 322 and 617 mg/sq m for Zn and between 6.2 and 11.3 mg/sq m for Cd. There were no significant differences in anthropogenic Zn or Cd burdens between

lakes. The lack of a relationship between Zn or Cd burdens and the ratio of watershed area to lake area or the water replenishment time of the lakes indicates that deposition from the atmosphere directly onto the lakes surfaces is an important input of these metals to the lakes. (Author's abstract)
W84-01973

EFFECT OF ATMOSPHERIC SULFUR ON THE COMPOSITION OF THREE ADIRONDACK LAKES,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. N. Galloway, C. L. Schofield, N. E. Peters, G. R. Hendrey, and E. R. Altwicker.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 6, p 799-806, June, 1983. 8 Fig, 2 Tab, 18 Ref.

Descriptors: *Water pollution sources, *Atmospheric deposition, *Oligotrophic lakes, *Sulfur, Forest watersheds, Ammonia, Nitrates, Chloride, Alkalinity, New York, Panther Lake, Woods Lake, Sagamore Lake.

Three watershed-lake systems of the Integrated Lake-Watershed Acidification Study (ILWAS) were investigated to determine the effects of atmospheric deposition on the chemical compositions of oligotrophic lakes. Panther, Woods, and Sagamore lakes are in the Adirondack State Park, New York. The watersheds are forested with a mixture of hard and soft woods and have areas of 1.24, 2.07, amd 49.7 sq km, respectively. Annually, about 90% of the NH4(+) and 50% of the NO3(-) from atmospheric deposition were retained in the systems. In the Woods system, Cl(-) was in steady state with respect to atmospheric deposition although both Panther and Sagamore systems had net losses, indicating watershed sources of Cl(-). The losses of base cations from Panther and Sagamore were substantially greater than from the Woods system, reflecting the shallow soils of the latter. The concentrations of SO4(2-) in the waters of the three systems were controlled by the atmospheric deposition of anthropogenic sulfur; in Woods and Panther, inputs (atmospheric deposition) equalled outputs (discharges from the lake outlets); in Sagamore, outputs exceeded inputs. In 1978-80, concentrations of SO4(2-) were four to five times higher than historical values. These increased concentrations had caused either decreased alkalinities of surface waters or increased concentrations of base cations or both. Decreased alkalinity directly affects aquatic ecosystems; increased concentrations of base cations directly affect terrestrial ecosystems because of increased rates of loss of the nutrients Ca, Mg, and K in the absence of resupply from primary weathering. (Moore-IVI)
W84-01976

INFLUENCE OF SEWAGE TREATMENT AND URBANIZATION ON SELECTION OF MULTIPLE RESISTANCE IN FECAL COLIFORM POPULATIONS,
Oxoid Canada, Inc., Nepean (Ontario).
J. B. Bell, G. E. Elliott, and D. W. Smith.
Applied and Environmental Microbiology, Vol. 46, No. 1, p 227-232, July, 1983. 6 Tab, 25 Ref.

Descriptors: *Coliforms, *Antibiotic resistance, *Wastewater treatment, Wastewater lagoons, Fecal coliforms, Urban areas, R factors, Effluents, Water quality, Wastewater management, Slave River, Red River, Canada.

The fecal coliform populations found in the raw sewages and final sewage effluents of mechanical treatment plants, a long-term retention lagoon, shorter-term retention lagoons, a remote northern Canada river, and a heavily urbanized prairie river were examined for antibiotic resistance and the possession of R factors. It was determined that there was a decrease in the percentage of multiresistant fecal coliform populations in the mechanical sewage treatment plants and shorter-term retention lagoons; however, there was an increase in populations from the long-term retention lagoon. The percentage of the populations possessing transmissible R factors was constant in the mechanical treatment and shorter-term retention facilities; however, the ability to transmit was lost in 50% of the infective population of the long-term retention facility. A striking contrast was found between the populations of the remote northern Slave River and those of the urbanized Red River. Of the fecal coliforms in the Slave River, 7.1% were multiresistant, and only 0.79% possessed transmissible R factors. The Red River fecal coliform populations were 52.9% multiresistant, and 18.77% of the total population possessed transmissible R factors. The influence of urbanization and the type of sewage treatment have been shown to affect the selection and survival of multiresistant fecal coliforms and R+ fecal coliforms. Determination of other factors influencing the development and the survival of these populations is needed for rational wastewater management and water quality consideration. (Author's abstract)
W84-02054

DEGRADATION AND TOTAL MINERALIZATION OF MONOHALOGENATED BIPHENYLS IN NATURAL SEDIMENT AND MIXED BACTERIAL CULTURE,
Tennessee Univ., Knoxville. Dept. of Microbiology.
H.-L. Kong, and G. S. Sayler.
Applied and Environmental Microbiology, Vol. 46, No. 3, p 666-672, September, 1983. 6 Fig, 3 Tab, 18 Ref. EPA grant R808457010.

Descriptors: *Monohalogenated biphenyls, *Bacteria, *Biodegradation, Degradation products, Mineralization, Polychlorinated biphenyls, River sediments, Water pollution effects, Solar radiation.

Mixed bacterial cultures obtained from polychlorinated biphenyl-contaminated river sediments are capable of degrading monohalogenated biphenyls under simulated natural conditions. Culture conditions include river water as supportive medium and mixed bacterial cultures obtained from river sediments. Degradation occurs when the substrates are supplied as the sole carbon source or when added together with glucose. The degradation rates of 2-, 3-, and 4-chlorobiphenyl, at 30 micro g/ml, were 1.1, 1.6, and 2.0 micro g/ml/day, respectively. Monobrominated biphenyls, including 2-, 3-, and 4-bromobiphenyl, were degraded at rates of 2.3, 4.2, and 1jIicro g/ml/day, respectively. Metabolites, including halogenated benzoates, were detected by high-performance liquid chromatography and mass spectrometry. By using chlorophenyl ring-labeled monochlorobiphenyls as substrates, total mineralization (defined as CO2 production from the chlorophenyl ring) was observed for 4-chlorobiphenyl but not for 2-chlorobiphenyl. Rates of total mineralization of 4-chlorobiphenyl (at 39 to 385 micro g/ml levels) were dependent on substrate concentration, whereas variation of cell number in the range of 105 to 107 cells/ml had no significant effects. Simulated sunlight enhanced the rate of mineralization by ca. 400%. (Author's abstract)
W84-02060

INVESTIGATIONS ON THE DETENTION SPECTRUM OF RIVER IMPOUNDMENTS USING NATURALLY PROVIDED TRACERS (ERMITTLUNG DES VERWEILZEITVERHALTENS EINES FLUBSTAUSEES MITTELS NATURLICHER, SYSTEMEIGENER TRACER),
Ruhrverband, Essen (Germany, F.R.). Chemisches und Biologisches Lab.
R. Klopp, J. Sommer, and K.-H. Kornatzki.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 2, p 61-65, 1983. 4 Fig, 1 Tab, 14 Ref.

Descriptors: *Reservoirs, *Detention time, *Mathematical models, Chloride, Tracers, Water quality.

A mathematical model is presented for the determination of the detention characteristics of river impoundments. The time dependent concentration of a naturally available, perseverant substance (chloride) being measured at the inlet and the outlet of an impoundment served as a tracer. Since the addition of a strange tracer substance is not necessary, all possible problems to be considered with such procedures do not occur. The method was successfully applied at the Ruhr impoundment 'Baldeneysee'. The results were most useful for the interpretation of observed water quality processes. (Author's abstract)
W84-02064

NUMERICAL EXAMINATION OF THE ELUTION OF AQUATIC SEDIMENTS (RECHNERISCHE BEHANDLUNG DER ELUTION VON SEDIMENTEN),
Technische Hochschule, Darmstadt (Germany, F.R.). Inst. fuer Wasserversorgung, Abwasserbeseitigung und Raumplanung.
For primary bibliographic entry see Field 2K.
W84-02068

APPLICATION OF IR-SPECTROSCOPY IN THE DEGRADATION OF ORGANIC SUBSTANCES; REPORT III. CATION TENSIDES (EINSATZ DER IR-SPEKTROSKOPIE BEIM ABBAU ORGANISCHER STOFFE; III. MITTEILUNG: KATIONTENSIDE),
Bundesanstalt fuer Gewaesserkunde, Coblenz (Germany, F.R.).
For primary bibliographic entry see Field 5D.
W84-02076

ACCUMULATION OF MERCURY IN FISH AND MAN FROM RESERVOIRS IN NORTHERN FINLAND,
Helsinki Univ. (Finland). Dept. of Environmental Science.
M. Lodenius, A. Seppanen, and M. Herranen.
Water, Air, and Soil Pollution, Vol. 19, p 237-246, 1983. 2 Fig, 4 Tab, 50 Ref.

Descriptors: *Mercury, *Fish, *Reservoirs, Finland, Water pollution sources, Human pathology, Environmental effects, Lakes, Bioaccumulation.

Increased mercury content in fish taken from recently impounded reservoirs in Finland has stimulated an investigation of possible accumulation of mercury. Samples of fish and human hair were analyzed for mercury content. The concentrations of mercury in fish from man-made lakes were higher than in fish from a natural lake. Fish of prey, such as burbot and pike, contained more mercury than other species of fish and higher values were recorded in the flesh than in the liver. In people the highest mercury concentrations were found in hair samples from middle-aged people eating substantial amounts of fish from reservoirs. The concentrations were high in males than in females, probably caused by a higher fish consumption. The larger amounts of mercury in the reservoirs than in natural lakes was caused both by construction and water control activities. The source of mercury in new impoundments is apparently the inundated soil but it is not understood how it is introduced to and accumulated in the limnetic foodchain. (Baker-IVI)
W84-02118

EXAMINATION OF BIOACCUMULATION AND BIOMAGNIFICATION OF METALS IN A PRECAMBRIAN SHIELD LAKE,
Guelph Univ. (Ontario). Dept. of Zoology.
C. D. Wren, H. R. Maccrimmon, and B. R. Loescher.
Water, Air, and Soil Pollution, Vol. 19, p 277-291, 1983. 1 Fig, 5 Tab, 43 Ref.

Descriptors: *Metals, *Lakes, *Bioaccumulation, *Biological magnification, Sediments, Clams, Birds, Mammals, Fish, Mercury, Trace metals, Trophic level, Tadenac Lake, Ontario.

A comprehensive examination of metal levels was made at various trophic levels within an undisturbed Precambrian shield lake ecosystem (Tadenac Lake, Ontario). Concentrations of 21 naturally occurring elements were measured in sediments, clams, fish, birds and mammals. Elements included Hg, Cu, Al, Ba, S, Ni, Cd, Ca, Be, Zn, P, Pb, Mg, Sr, Fe, V, Mo, Mn, Ti, B, and Co. Elevated sediment concentrations of Mn and Zn may be due to the presence of local sources of mineralization. Aquatic organisms in contact with sediments were able to accumulate very high levels

of certain metals relative to other species. The metal levels measured in benthic organisms may reflect natural sediment charactertistics which should be taken into account when using such animals as biological indicators of contamination. Of the elements studied, only mercury bioaccumulated in the fish species examined. Mercury accumulated in higher trophic levels and displayed biomagnification between three mammal species. Fish eating birds contained high levels of Hg, Cu, Fe, and Zn and to a lesser extent Al, relative to the fish examined. The observed higher levels of some trace metals in birds and mammals relative to fish may represent normal biological retention of certain essential elements, rather than contaminant biomagnification. (Baker-IVI)
W84-02119

TRANSPORT OF PHOSPHORUS IN SURFACE RUNOFF AS INFLUENCED BY LIQUID AND SOLID FERTILIZER PHOSPHATE ADDITION,
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
A. N. Sharpley, and J. K. Syers.
Water, Air and Soil Pollution, Vol. 19, No. 4, p 321-326, May 1983. 2 Fig, 1 Tab, 18 Ref.

Descriptors: *Fertilizers, *Phosphorus, *Agricultural runoff, Water pollution sources, Water pollution control, Particulates, Pastures, Surface runoff, Agricultural chemicals, Superphosphate.

The effects of superphosphate (50 kg P/ha), applied as a liquid or a solid, on transport of dissolved and particulate P in surface runoff from established pasture were evaluated using field plots and natural rainfall. An approximately 3-fold increase in the transport of both dissolved inorganic P and particulate P in surface runoff was measured in 14 weeks following fertilizer application in the solid form (2.9 and 2.9% of the applied fertilizer P, respectively) compared to the liquid application (1.0 and 1.1% of the applied fertilizer P, respectively). The application of solid fertilizer P has a more sustained effect on the concentration of both dissolved and particulate P in surface runoff. The concentration of particulate P had not returned to the prefertilizer levels some 16 weeks after the application of solid P. Although the application of liquid fertilizer P reduced losses of P in surface runoff from pasture compared to a solid application, the agronomic effectiveness of the two forms must be considered. Since solid fertilizer is more effective on pasture than liquid fertilizer (on an equal cost basis), the use of liquid fertilizer may only be an economic method of reducing P transport in runoff from agricultural land which has a high P-loading potential. (Moore-IVI)
W84-02121

ACID RAIN DEPOSITION PATTERNS IN THE CONTINENTAL UNITED STATES,
Flow General, Inc., McLean, VA.
J. Wisniewski, and E. L. Keitz.
Water, Air and Soil Pollution, Vol. 19, No. 4, p 327-339, May 1983. 3 Fig, 1 Tab, 28 Ref. EPA contract 68-01-5051.

Descriptors: *Acid rain, *Spatial distribution, Precipitation, Hydrogen ion concentration, Maps, Canada, United States.

Maps of both pH and H(+) deposition in precipitation have been developed for the continental United States by analyzing laboratory pH data from nine precipitation chemistry networks and two single stations spread across the continental United States and southern Canada during the late 1970's. Average laboratory pH values were obtained or calculated for approximately 100 stations, and isopleths of weighted mean pH and mean annual H(+) deposition in precipitation were drawn. In spite of a wide variety of collection methods and sampling intervals, there is remarkable uniformity in the average pH among the various stations. Precipitation remains most acidic in the heart of the northeastern section of the United States. The next highest level of precipitation acidity occurs in the surrounding area, which includes the Ohio Valley and southern Ontario regions. Evidence of precipitation acidity is now appearing in Florida, the Colorado Rockies and in population canters along the west coast, where pH values at or below 5 are now recorded. Hugh data gaps are apparent in the western portion of the country. Even though most western areas are not experiencing acidities at this time, the need for additional monitoring is important due to projected western energy development. (Moore-IVI)
W84-02122

5C. Effects Of Pollution

TOXICITY OF SELECTED PRIORITY POLLUTANTS TO VARIOUS AQUATIC ORGANISMS,
Environmental Research Lab.-Duluth, MN.
G. W. Holcombe, G. L. Phipps, and J. T. Fiandt.
Ecotoxicology and Environmental Safety, Vol. 7, No. 4, p 400-409, August, 1983. 4 Tab, 18 Ref.

Descriptors: *Toxicity, *Organic compounds, *Aquatic populations, Enviromental effects, Water pollution effects, Acenaphthene, Arsenic trioxide, Cadmium chloride, Mercury chloride, Silver nitrate, Chlordane, Endosulfan, Heptachlor, Pesticides, Fish.

Toxicity tests were conducted with selected compounds listed by the United States Environmental Protection Agency as priority pollutants. Acute toxicity information was determined for acenaphthene, arsenic trioxide, cadmium chloride, mercury (II) chloride, silver nitrate, chlordane, endosulfan, and heptachlor. Acute tests were conducted using one or more of the following species: fathead minnows (Pimephales promelas), channel catfish (Ictalurus punctatus), rainbow trout (Salmo gairdneri), brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), bluegills (Lepomis macrochirus), snails (Aplexa hypnorum), or chironomids (Tanytarsus dissimilis). Acute values from these tests ranged from a silver nitrate 96-hr median of 6.7 micrograms/liter for fathead minnows to an arsenic trioxide 48-hr lethal dose of 97,000 micrograms/liter for chironomids. In addition to acute tests, a fathead minnow embryo-larval exposure was conducted with silver nitrate to estimate chronic toxicity. The estimated maximum acceptable toxicant concentration for silver nitrate, based on fathead minnow survival, lies between 0.37 and 0.65 micrograms/liter. (Author's abstract).
W84-01824

HISTOLOGICAL OBSERVATIONS IN GILLS OF THE TELEOST SAROTHERODON MOSSAMBICUS WITH REFERENCE TO MERCURY TOXICITY,
Sri Venkateswara Univ., Tirupati (India). Dept. of Zoology.
K. A. Naidu, K. A. Naidu, and R. Ramamurthi.
Ecotoxicology and Environmental Safety, Vol. 7, No. 5, p 455-462, October, 1983. 12 Fig, 9 Ref.

Descriptors: *Mercury, *Toxicity, Histology, Pesticides, Mercury chloride, Industrial wastes, Water pollution effects, Environmental effects.

Histological changes in the gills of Sarotherodon mossambicus exposed to lethal and sublethal concentrations of mercuric chloride were recorded. The characteristics of the test medium (tap water) were: pH 7.0-7.3; alkalinity 9.7 ppm of CaCO3; dissolved oxygen 5.3-6.2 mg/liter; hardness 35 ppm of CaCO3; and temperature 28-32 degrees C. The first group was exposed to 1.5 ppm of mercuric chloride, while the second, third, and fourth groups were exposed to 0.1 ppm of mercuric chloride for 1, 15, and 30 days, respectively. Gross structure of gill filaments appeared normal. Microscopic changes were noted in secondary gill lamellae and interlamellar cells of exposed fish. In the lethal exposure group the secondary gill lamellae were enlarged into bulb-like structures. These bulgings were notes at distal and basal portions of the lamellae. Some of the lamellae were collapsed. Necrosis and desquamation of the lamellae were also noted. In sublethal exposure after one day, in addition to bulgings at the tips of the lamellae, there were hypertrophy and hyperplasia of lamellar and interlamellar cells. In 15-day exposed fish, separation of the epithelial layer of gill lamellae from pillar cells was the prominent feature. Blood spaces between pillar cells of the lamellae were empty. Such damage will probably affect the respiratory function of the gill by reducing respiratory surface area. (Baker-IVI)
W84-01825

BRACKISH-WATER AQUACULTURE IN PYRITE-BEARING TROPICAL SOILS,
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 2K.
W84-01834

RESTORATION OF NORWEGIAN LAKES BY REDUCTION IN SULPHUR DEPOSITION,
Norsk Inst. for Vannforskning, Oslo.
R. F. Wright, and A. Henriksen.
Nature, Vol. 305, No. 5933, p 422-424, September, 1983. 3 Fig, 13 Ref.

Descriptors: *Acid rain, *Fish Lakes, Acidity, Sulfur, Water pollution effects, Norway.

Acid precipitation, causing the acidification of freshwaters and hence damage to fisheries, affects more than 33,000 sq km of southern Norway. As a first step in dealing with the acidification problem, Norway, Sweden and Finland have proposed that emissions of sulfur in Europe be reduced by 30% by 1993. Using data from a 1974-75 survey of major-ion chemistry and fish populations in 683 lakes in southern Norway, a 30% reduction in sulfur deposition will restore chemical conditions such that 22% of the lakes now experiencing fisheries problems should be able to support fish. The method of prediction derives from empirical relationships between sulfur deposition, water chemistry and fisheries status for several thousand lakes and rivers in Europe and North America. The method takes into account lake-to-lake differences in sensitivity, changes in base cation concentrations, and the buffering of dissolved aluminium at pH readings less than 5.4 and of bicarbonate at pH levels greater than 5.4. (Baker-IVI)
W84-01841

OCCURRENCE OF SOME INDICATOR BACTERIA IN THE WATERS OF AL-KHAIR STREAM, AND AL-JAISH CANAL PASSING THROUGH BAGHDAD CITY,
Biological Research Center, Baghdad (Iraq). Dept. of Environmental Pollution.
S. F. Jazrawi, and M. W. Ishaq.
Journal of Environmental Science and Health, Vol. A18, No. 5, p 673-684, September, 1983. 1 Fig, 3 Tab, 11 Ref.

Descriptors: *Bacteria, *Water quality, *Coliforms, Fecal coliforms, Streptococci, Baghdad, Iraq, Domestic waste.

Water samples were collected from twelve stations located in two water sources in Baghdad city. Samples were monitored for total aerobic bacteria, total coliforms, fecal coliforms and fecal streptococci. Samples were collected monthly from December of 1980 to December of 1981. High counts of pollution indicator were observed at all stations studied and were distributed independently of temperature, pH, and chloride concentration of the water samples. Total bacteria numbered from 2000 to 9000/ml in Al-Khair stream water and 2000 to 6000 m/l in the water of Al-Jaish canal. The population of total coliforms in the water of Al-Khair stream varied between 1000 and 4000/100 ml and that of fecal coliforms was between 0 and 3000/100 ml. Whereas the number of total coliforms and fecal coliforms in the water of Al-Jaish canal varied from 1000 to 55000/100 ml and from 0 to 100000/100 ml respectively. Numbers of total and fecal coliforms were highest in December which may be associated with the heavy rainfall which occurred within 24 hrs of sampling. Fecal streptococci were present mainly in lower amounts than the fecal coliforms in water samples. The constant presence of the indicator organisms in the samples

was due to the fact that there is continuous discharge of untreated domestic wastes in these two water sources. No periodic self purification was observed in the waters of these sources. Therefore, these water sources are not suitable for public water supplies, swimming, or recreational purposes. (Baker-IVI)
W84-01859

CONTAMINATION OF A MAJOR WATER SUPPLY BY GULLS (LARUS SP.); A STUDY OF THE PROBLEM AND REMEDIAL ACTION TAKEN,
Strathclyde Regional Council, Glasgow (Scotland). Water Dept.
C. Benton, F. Khan, P. Monaghan, W. N. Richards, and C. B. Shedden.
Water Research, Vol. 17, No. 7, p 789-798, 1983. 5 Fig, 4 Tab, 23 Ref.

Descriptors: *Water pollution sources, *Storage reservoirs, *Gulls, *Coliforms, Bacteria, Water pollution prevention, Salmonella, Water supply, Scotland, Glasgow.

In recent years one of the storage reservoirs supplying Loch Katrine water to Glasgow exhibited a serious deterioration in bacterial quality. This was associated with the winter nocturnal roosting habits of gulls (Larus sp.) on the reservoir. Investigations showed a significant correlation between the number of gulls roosting and the numbers of E. coli present in the water. Salmonellae organisms of identical serotypes were isolated from the gulls, from the untreated water and, on three occasions, from the treated water. Broadcasting species specific distress calls of Larus gulls proved to be an effective measure for discouraging gulls from roosting on the reservoir. The routine use of this bio-acoustic method of gull scaring reduced the bacteria in the water to numbers typical of an upland unpolluted reservoir. (Author's abstract)
W84-01897

EFFECT OF ACIDIFICATION, METALS AND METALLOIDS ON SEDIMENT MICROORGANISMS,
Waterloo Univ. (Ontario). Dept. of Biology.
M. D. Baker, W. E. Inniss, C. I. Mayfield, and P. T. S. Wong.
Water Research, Vol. 17, No. 8, p 925-930, 1983. 4 Fig, 1 Tab, 21 Ref.

Descriptors: *Lake sediments, *Hydrogen ion concentration, *Microorganisms, *Decomposition, *Metals, *Metalloids, Water temperature, Lead, Mercury, Arsenic, Selenium, Toxicity, Bacteria, Ontario, Plastic Lake.

Using sediment from Plastic Lake near Dorset, Ontario, the effects of pH changes, metals and metalloids on sediment microorganisms were studied. The mineralization of C-14 glucose was reduced in sediments of pH 4 and 5 compared to pH 7. A large reduction in glucose mineralization was also observed at low temperature (0 degrees C). The majority of bacterial isolates recovered at incubation temperatures of 0 and 20 degrees C were psychrotrophic and the majority of both populations was resistant to lead and selenium while a smaller proportion was resistant to mercury and arsenic. Many of the bacteria were resistant to more than one of the elements. Lead and mercury were more toxic to bacterial growth at pH 4.5 than at 7.5, while selenium and arsenic were slightly more toxic at the higher pH values. The reduction in microbial activity may explain the observed accumulation of organic matter in some acidic lakes. Another factor in such accumulations may be the increase in metal and metalloid concentrations under low pH conditions. (Moore-IVI)
W84-01904

EFFECT OF AN INDUSTRIAL AMMONIA DISCHARGE ON THE DISSOLVED OXYGEN REGIME OF THE WILLAMETTE RIVER, OREGON,
Oregon State Dept. of Environmental Quality, Portland.
D. A. Dunnette, and R. M. Avedovech.
Water Research, Vol. 17, No. 9, p 997-1007, 1983. 5 Fig, 6 Tab, 41 Ref.

Descriptors: *Ammonia, *Nitrification, *Water pollution effects, *Dissolved oxygen, *Willamette River, Oregon, Industrial wastewater, Bacteria, Simulation, Computer models, Nitrates.

An industrial discharge of 7000-10,000 kg/day ammonia nitrogen can exert a very great impact on the oxygen regime of the lower Willamette River, Oregon through the microbially mediated process of nitrification. This conclusion is based upon the following evidence: inorganic nitrogen mass flow data; measured reductions in Willamette River dissolved oxygen during ammonia discharge as compared to non-discharge conditions; the present of nitrifying bacteria in mud and attached to aquatic vegetation and river cobbles; verification of a dissolved oxygen model based upon nitrification as a primary ammonia sink and a dominant deoxygenation process; and N-15 heavy isotope tracer studies indicating significant conversion of ammonia to nitrate. Chemical evidence indicates and a dissolved oxygen computer simulation model verifies that a reduction of approximately 50% in as industrial ammonia discharge of several metric tons per day was the major factor in a dissolved oxygen increase of 15% on the lower Willamette River between 1973 and 1979. A shallow, fast flowing, highly surface active and ammonia enriched reach of the river was identified as a reach of high impact active nitrification. In an actively nitrifying reach of the Willamette River a gradual increase in nitrate nitrogen from 0.2 to 0.4 mg/l was observed in a distance of about 53 km. Based on a flow rate of 184 cu m/s this is equivalent to about 3180 kg of ammonia nitrogen nitrified per day in this reach assuming no additional nitrate sources or sinks. (Moore-IVI)
W84-01906

ASSESSING AQUATIC PRODUCTIVITY IN THE HOUSATONIC RIVER USING THE ALGAL ASSAY: BOTTLE TEST,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
N. M. Ram, and S. Plotkin.
Water Research, Vol. 17, No. 9, p 1095-1106, 1983. 6 Fig, 5 Tab, 32 Ref.

Descriptors: *Eutrophication, *Productivity, *Algae, *Water pollution effects, *Housatonic River, Connecticut, Massachusetts, Phosphorus, Nitrogen, Nutrients, Phosphorus removal, Wastewater treatment, Effluent.

Dense algal growth and large diurnal oxygen variations in both free flowing and impounded reaches of the Housatonic River in Connecticut and Massachusetts prompted a concentrated study to assess the need for a comprehensive basin wide phosphorus abatement program and the contribution of point source discharges to eutrophication of the river. Inorganic nutrient levels and bioassay data indicated a predominance of nitrogen limitation below Pittsfield, MA resulting from discharges of phosphorus-rich, municipal and industrial wastewater into the river. N:P ratios suggested that the nutrient status of the river varied, to some extent, even over as short an interval as 2 months and was probably attributable to flow variations in the river. Algal assays of water samples confirmed the nutrient limitation predicted by N:P ratios in 10 out of 13 cases. Additions of varying percentages of untreated, and alum-treated Pittsfield domestic wastewater treatment plant effluent to Housatonic River water, resulted in a linear increase in algal yield that was within 20% of values predicted by inorganic nutrient content. No significant reduction in algal growth response was observed, however, in the alum-treated sewage since its N:P ratio was not sufficiently shifted to phosphorus limitation after 66% phosphorus removal (Al:P equal to 1.3:1). Phosphorus removal at Best Practicable Technology levels would therefore probably not change the nutrient status of the Pittsfield wastewater to phosphorus limitation. (Author's abstract)
W84-01910

ACUTE TOXICITY OF PICRIC ACID AND PICRAMIC ACID TO RAINBOW TROUT SALMO GAIRDNERI, AND AMERICAN OYSTER, CRASSOSTREA VIRGINICA,
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
W. L. Goodfellow, Jr., D. T. Burton, W. C. Graves, L. W. Hall, Jr., and K. R. Cooper.
Water Resources Bulletin, Vol. 19, No. 4, p 641-648, August, 1983. 2 Fig, 4 Tab, 38 Ref. Army grant ARMY M1PR 2506.

Descriptors: *Picric acid, *Picramic acid, *Toxicity, *Trout, *Oysters, Estuarine environment, Sediment contamination, Water pollution effects, Nitrophenols, Adsorption.

Picric acid (2,4,6-trinitrophenol) and picramic acid (2-amino-4,6-dinitrophenol) are potential water pollutents due to a variety of industrial and munition uses. The possible impacts of picric and picramic acid to two recreationally and commercially important species, rainbow trout, Salmo gairdneri, and American oysters, Crassostra virginica, were evaluated. Picramic acid was more toxic than picric acid to both species tested. The 96-h LC50s for picric and picramic acids for rainbow trout were 109.6 and 46.2 mg/l, respectively. The 144-h LC50s for picric and picramic acid for American oysters were 254.9 and 69.8 mg/l, respectively. Sublethal no growth EC50s and shell deposition EC50s for oysters showed that both compounds caused adverse effects at much lower concentrations than indicated by the LC50s. For example, the 144-h shell deposition EC50s were 27.9 mg/l for picric acid and 5.6 mg/l for picramic acid. Sediment adsorption studies in estuarine water indicated that both compounds are not readily adsorbed which suggests that sediment would not play a major role as a sink in contaminated systems. Oysters, which filter large quantities of particulate matter, would more likely be affected by picric and picramic acids in the water column than by exposure to contaminated sediment. (Author's abstract)
W84-01951

ONONDAGA LAKE AND DISSOLVED OXYGEN IN SENECA RIVER,
Upstate Freshwater Inst., Syracuse, NY.
S. W. Effler, P. Jaran, and C. F. Carter.
Journal of Environmental Engineering, Vol. 109. No. 4, p 945-951, August, 1983. 1 Fig, 1 Tab, 15 Ref.

Descriptors: *Dissolved oxygen, *Lakes, Lake Onondaga, Seneca River, New York, Rivers, Phytoplankton, Water pollution effects, Stratification.

The Seneca River is part of the Three Rivers system, which drains more than 5,000 sq miles of Central New York to Lake Ontario. There are indications that the source of ionic pollution to the lake, and the chemically-based stratification in the river, may be eliminated in the future. An evaluation is presented, conducted by model simulation, of the impacts the removal of chemical stratification and the range of behavior of released lake phytoplankton would have on the dissolved oxygen resources of the river, under critical flow, temperature, and loading conditions. Simulations for both stratified and nonstratified conditions were performed. The lack of density stratification is predicted to result in greater stress on the system and substantial contravention of river standards. There are a number of limitations in this analysis, prime of which is the lack of unequivocal model calibration. Further, the model framework may be overly simplistic with respect to dimensionality and the omission of dispersive transport. However, more complex models have greater input requirements. (Baker-IVI)
W84-01957

EFFECTS OF CHANGES IN PH ON TRANSPARENCY AND THERMAL REGIMES OF LOHI LAKE, NEAR SUDBURY, ONTARIO,
Ontario Ministry of the Environment, Rexdale. Limnology and Taxonomy Section.

For primary bibliographic entry see Field 2H.
W84-01974

STRUCTURE-TOXICITY RELATIONSHIPS FOR THE FATHEAD MINNOW, PIMEPHALES PROMELAS: NARCOTIC INDUSTRIAL CHEMICALS,
Environmental Research Lab.-Duluth, MN.
G. D. Veith, D. J. Call, and L. T. Brooke.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 6, p 743-748, June, 1983. 3 Fig, 2 Tab, 18 Ref. EPA cooperative agreement CR809234-01.

Descriptors: *Toxicity, *Fathead minnows, *Organic compounds, Industrial chemicals, Narcosis, Alcohols, Ketones, Ethers, Alkyl halides, Benzenes, Partition coefficient, Molecular structure.

Narcosis is a reversible state of arrested activity of protoplasmic structures caused by a wide variety of organic chemicals. This nonspecific mode of toxic action was found predominant in acute toxicity studies of industrial chemicals and fish. This paper presents 96-h LC50 values for 65 industrial chemicals including alcohols, ketones, ethers, alkyl halides, and substituted benzenes. The common mode of action permitted the development of a structure - toxicity relationship as follows: log LC50 = -0.94 log P + 0.94 log (0.000068P + 1) - 1.25 where P is the n-octanol/water partition coefficient. The data show that the toxicity of the chemicals to fish is directly comparable with the toxicity in mammals when expressed as chemical activity. (Author's abstract)
W84-01975

ZINC, MANGANESE, AND STRONTIUM IN OPERCULA AND SCALES OF BROOK TROUT (SALVELINUS FONTINALIS) AS INDICATORS OF LAKE ACIDIFICATION,
Laval Univ., Quebec. CENTREAU.
G. Moreau, C. Barbeau, J. J. Frenette, J. Saint-Onge, and M. Simoneau.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 10, p 1685-1691, October, 1983. 1 Fig, 6 Tab, 41 Ref.

Descriptors: *Trout, *Water pollution effects, *Lake acidification, Fish scales, Fish opercula, Zinc, Magnesium, Zinc, Manganese, Strontium.

Calcium, magnesium, zinc, manganese, and strontium were analyzed in opercula and scales of 148 brook trout (Salvelinus fontinalis) from three acidified and three nonacidified lakes in Laurentian Park north of Quebec. In the acidified lakes, the content in manganese, zinc, and strontium is 1.6, 1.3, and 1.2 times higher than in the nonacidified lakes, whereas the concentrations in calcium and magnesium are not significantly different. A discriminant analysis correctly classifies more than 80% of all specimens. Furthermore, a cluster analysis based on zinc and magnesium concentrations in opercula is successful in grouping 73 and 78%, respectively, of fish from nonacidified and acidified lakes. (Author's abstract)
W84-01980

CAN WE SAVE THE CHESAPEAKE BAY,
C. Joyce.
New Scientist, Vol. 97, No. 1350, p 797-800, 24 March, 1983. 4 Fig.

Descriptors: *Estuaries, *Water pollution effects, *Environmental effects, *Chesapeake Bay, Nutrients, Nitrogen, Phosphorus, Acid rain, Bays, Aquatic life.

In efforts to stop the disappearance of anadromous fish, crab, oyster, and plant life in the Chesapeake Bay area, a study was undertaken which divided the Bay into geographical units but kept in mind the fact that each of these units works with the others in the total ecosystem picture. These units included the tidal freshwaters at the heads of any of the dendritic tributaries that feed the bay, and the turbidity-maximum area where circular currents raise a curtain of sediments and living things. Human influence has been cited as the largest of the causes of the bay's ills. The ever increasing supply of nutrients in the estuary is possibly the major cause behind the thickening of the bay's waters. Scores of sewage plants along the Cheasapeake's tributaries are disgorging nitrogen and phosphorus, natural products of biological sewage treatment. Nitrogen comes in large part from the runoff of fertilizers. In the future, however, current findings indicate that atmospheric deposition of nitrogen especially as nitrate, may well overtake deposition from land runoff. (Baker-IVI)
W84-02012

MICROCOSM AND EXPERIMENTAL POND EVALUATION OF MICROBIAL COMMUNITY RESPONSE TO SYNTHETIC OIL CONTAMINATION IN FRESHWATER SEDIMENTS,
Tennessee Univ., Knoxville. Dept. of Microbiology.
G. S. Sayler, R. E. Perkins, T. W. Sherrill, B. K. Perkins, and M. C. Reid.
Applied and Environmental Microbiology, Vol. 46, No. 1, p 211-219, July, 1983. 3 Fig, 5 Tab, 17 Ref. OWRT grant 14-34-001-9096.

Descriptors: *Microorganisms, *Oil pollution, *Sediments, Water pollution effects, Synthetic oil, Hydrocarbons, Aromatic compounds, Ecosystems, Mineralization.

A multivariate approach was used to evaluate the significance of synthetic oil-induced perturbations in the functional activity of sediment microbial communities. Total viable cell densities, ATP-biomass, alkaline phosphates and dehydrogenase activity, and mineralization rates of glucose, protein, oleic acid, starch, naphthalene, and phenanthrene were monitored on a periodic basis in microcosms and experimental ponds for 11 months, both before and after exposure to synthetic oil. All variables contribute to significant discrimination between sediment microbial responses in control communities and communities exposed to a gradient of synthetic oil contamination. At high synthetic oil concentrations (4,000 ml/12 cu m), a transient reduction in sediment ATP concentrations and increased rates of oleic acid mineralization were demonstrated within 1 week of exposure. These transient effects were followed within 1 month by a signficant increase in rates of naphthalene and phenanthrene mineralization. After initial construction, both control and synthetic oil-exposed microbial communities demonstrated wide variability in community activity. All experimental microbial communities approached equilibrium and demonstrated good replication. However, synthetic oil perturbation was demonstrated by wide transient variability in community activity. This variability was primarily the result of the stimulation of polyaromatic hydrocarbon mineralization rates. In general, microcosms and pond communities demonstrated sufficient resiliency to recover from the effects of synthetic oil exposure within 3 months, although polyaromatic hydrocarbon mineralization rates remained significant elevated. (Author's abstract)
W84-02053

INVESTIGATIONS ABOUT THE INFLUENCE OF SMALL NTA-CONCENTRATIONS ON THE FLOCCULATION PROCESS (UNTERSUCHUNGEN UBER DEN EINFLUSS KLEINER NTA-KONZENTRATIONEN AUF DEN FLOCKUNGSPROZESS),
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W84-02063

PROBLEM OF CLASSIFICATION OF ACIDIFIED WATERCOURSES (ZUR PROBLEMATIK DER GUTEBEURTEILUNG VON SAUREN FLIESSGEWASSERN),
Gesamthochschule Kassel (Germany, F.R.). Fachbereich Biologie Chemie.
U. Matthias.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 3, p 107-110, 1983. 4 Fig, 1 Tab, 20 Ref.

Descriptors: *Acid streams, *Species composition, Kaufunger Wald, West Germany, Shrimp, Mayflies, Water pollution effects.

In the Kaufunger Wald Nature Park, situated east of Kassel, (Germany, F.R.) numerous small watercourses were investigated from the chemical/physical and faunistic viewpoints over a period of two years. It was discovered that a large number of the streams were acidified to varying degrees and had a much reduced biocoenosis in comparison with neutral watercourses. This species reduction had no influence on the classification, since all of the watercourses investigated were assigned to Quality Class I or I-II on the Hessian water classification map. In future water classifications, such acidification phenomena should be taken into account, since they result in a serious deterioration of the biocoenosis, as in the case of sewage input. In particular, the absence of acid-sensitive freshwater shrimps (Gammaridae) and mayflies (Ephemeroptera), which normally inhabit every non-polluted low-mountain brook, can provide evidence of possible acidification in weakly buffered waters with a low lime concentration. (Author's abstract)
W84-02069

INFLUENCE OF DISSOLVED OXYGEN LEVELS ON ACUTE TOXICITY OF PHENOLIC COMPOUNDS TO FRESH WATER TELECOST, NOTOPTERUS NOTOPTERUS (PALLAS),
Punjab Agricultural Univ., Ludhiana (India). Dept. of Zoology.
S. Gupta, R. C. Dalela, and P. K. Saxena.
Water, Air, and Soil Pollution, Vol. 19, p 223-228, 1983. 3 Tab, 15 Ref.

Descriptors: *Dissolved oxygen, *Toxicity, *Phenols, Organic compounds, Insecticides, Agricultural chemicals, 2,4-Dinitrophenol, Pentachlorophenol, Phenol, Fish, Notopterus.

Specimens of the fresh water fish Notopterus notopterus were exposed to phenol (P), 2,4-dinitrophenol (DNP), and pentachlorophenol (PCP) separately and in three combinations at three dissolved oxygen levels, 5, 6.5, or 7.8 mg/l for 96 hr in order to determine the influence of dissolved oxygen on the toxicity of phenolic compounds individually and in combination. A decrease in dissolved oxygen level from 6.5 mg/l increased the toxicity of P, DNP, PCP, and the three combinations by 88.0, 188.01, 219.0, and 123-610%, respectively. An increase in dissolved oxygen level from 6.5 to 7.8 mg/l decreased their toxicity by 31.0, 31.6, 22.5, and 23-55%, respectively. The increase in toxicity of these chemicals noted at low dissolved oxygen levels may be explained on the basis that at low dissolved oxygen levels fish must pass more water over the gills in order to obtain sufficient quantities of oxygen. As a result the fish absorb more toxicants via gills than they do at higher dissolved oxygen levels. Consistently, this produces lesions in the gills and also interferes with the normal gas exchange process. (Baker-IVI)
W84-02117

MACROBENTHOS OF LAKE NAINI TAL (U.P., INDIA) WITH PARTICULAR REFERENCE TO POLLUTION,
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
P. K. Gupta, and M. C. Pant.
Water, Air, and Soil Pollution, Vol. 19, p 397-405, 1983. 6 Fig, 3 Tab, 16 Ref.

Descriptors: *Benthic environment, *Lakes, *Water pollution effects, Lake Naini Tal, India, Water depth, Benthos, Biological communities.

The important attributes of macrobenthic community structure such as species composition and number, population density, biomass, and dominance and diversity indices were measured at different depths and discussed in relation to pollution of Lake Naini Tal (India). The lake is fed by 22 seasonal and 2 perennial open drains carrying large amounts of domestic waste, urban runoff, and silt into the lake, which are main sources of pollution.

A total of 30 species were recorded from the entire lake. The total number of species, taxonomic groups, density, biomass and diversity index declined with depth up to 7 m; thereafter macrobenthos disappeared. Three different zones of pollution in the lake were distinguished: heavily polluted zone below 7 m, moderately polluted zone between 5 and 7 m depths, and pollution influenced zone from 0 to 5 m depths. As the major part of the lake had become afaunal, there is an urgent need to exercise control on the activities which tend to increase pollution. (Baker-IVI)
W84-02123

5D. Waste Treatment Processes

INTEGRATED WASTEWATER MANAGEMENT,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
B. R. Kansakar, and C. Polprasert.
Journal of Environmental Engineering, Vol. 109, No. 3, p 619-630, June, 1983. 2 Fig, 7 Tab, 15 Ref.

Descriptors: *Wastewater management, *Sludge management, Goal programming, Network design, Costs, Land use, Environmental effects, Water quality, Computer models, Interceptors, Sludge disposal, Routing.

A multiobjective goal programming method is proposed for use in analyzing problems involving a network flow structure which are commonly found in the wastewater and sludge management systems when cost functions are linear. The goals considered are the minimization of: (1) costs, (2) water quality impact, and (3) land use impact. The model also selects interceptor routes, treatment plants, transport routes and sludge disposal sites, along with flow directions through these facilities under optimal solutions. A hypothetical example problem dealing with regional wastewater management is analyzed to demonstrate the potential usefulness of the method. (Author's abstract)
W84-01771

ANAEROBIC BIOTECHNOLOGY FOR INDUSTRIAL WASTEWATER TREATMENT,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
R. E. Speece.
Environmental Science and Technology, Vol. 17, No. 9, p 416A-427A, 1983. 4 Fig, 4 Tab, 97 Ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Anaerobic conditions, Bacteria, Methanogens.

The majority of industrial wastewaters that appear to be good candidates for anaerobic treatment now require new phases of inquiry. The basic question centers around the rate at which the wastewater is degradable, and to what degree. The bioconversion of the organic feedstocks in industrial wastewaters to methane is accomplished by a consortium of bacteria comprised of chemoheterotrophic, nonmethanogenic bacteria and methanogenic bacteria. Methanogens are often considered the key class of microorganisms in anaerobic biotechnology. At least three cofactors are apparently unique to methanogens, and recently a newly discovered cofactor, 2-mercaptoethanesulfonic acid, has been found in all methanogens available in pure culture except Methanobacterium ruminantium, which requires it for growth. Since complex wastewaters containing organics have a continuous range of degradation rates, at low loading rates, the rate-controlling step may be acid formation, as is evidenced by low volatile acids concentrations. As the loading rate increases, the methanogenesis stage may gradually become the rate-controlling step, as evidenced by an accumulation of volatile acids. One problem which can be a serious hindrance to the commercialization anaerobic biotechnology lies in the lack of understanding of the trace nutrient requirements of methanogens. The number of substrates that have been proven amenable to anaerobic biotechnology is quite extensive. One major consideration inherent in anaerobic biotechnology is the relatively low synthesis ration of the methanogens. Special attention must be paid to ensure efficient retention of the biomass in the system. (Baker-IVI)
W84-01778

REDUCING WATER DEMAND AND WASTEWATER FLOW,
Brown and Caldwell, Walnut Creek, CA.
For primary bibliographic entry see Field 3D.
W84-01796

OPTIMIZING LARGE-SCALE WATER TREATMENT PLANTS FOR ASBESTOS-FIBER REMOVAL,
Southern California Metropolitan Water District, La Verne. Water Quality Branch.
M. J. McGuire, A. E. Bowers, and D. A. Bowers.
Journal of the American Water Works Association, Vol. 75, No. 7, p 364-370, July, 1983. 19 Fig, 4 Tab, 12 Ref.

Descriptors: *Water treatment, *Filtration, *Asbestos, Turbidity, Drinking water, Colorado River, California.

Standard and optimized treatment were alternated at five filtration plants in southern California that receive low to high concentrations of chrysotile asbestos fibers in their influents. The removals of asbestos fibers and turbidity by these plants are reported. Asbestos fiber concentrations in the five treatment plants influents were different because of the different sources of supply, the presence or absence of source-water reservoirs, and variations in the blends of the Colorado River water and the water in the state project. The ability of each plant to remove asbestos fibers was dependent on the asbestos concentration in the influent and the efficiencies of the individual treatment processes. In two cases (Weymouth and Diemer plants) a high percentage of removal of asbestos fibers did not result in levels as low as those at a plant that was less effective in particle removal. The 0.10 ntu goal for fiber effluent turbidity was not achieved on a consistent basis by all five treatment plants. One particular plant had trouble meeting the goal probably due to a problem with balancing flows and with a lack of continuous effluent turbidity monitoring equipment. Attainment of the 0.10-ntu level did not guarantee a low effluent asbestos concentration. In general, optimized treatment resulted in lower effluent asbestos concentrations than standard treatment. However, many of the effluent asbestos levels determined in this study were much higher than those reported in the literature. It appears that there is little hope of using 0.10 ntu as a surrogate level for asbestos fibers in treated drinking water. (Baker-IVI)
W84-01801

ENVIRONMENTAL STUDIES OF ENTERIC BACTERIA LONGEVITY IN MEMBRANE FILTER CHAMBERS,
National Water Research Inst., Burlington (Ontario). Analytical Methods Div.
B. J. Dutka, and K. K. Kwan.
Journal of the American Water Works Association, Vol. 75, No. 7, p 380-382, July, 1983. 2 Fig, 4 Tab, 9 Ref.

Descriptors: *Bacteria, *Seasonal variation, Wastewater treatment, Disinfection, Effluent, Water pollution sources, Escherichia coli, Klebsiella, Salmonella, Streptococcus, Serratia, Survival time, Public health.

Two studies were carried out over several seasons to ascertain the survival of pathogenic, indicator, and tracer bacteria in membrane filter chambers. The chambers were placed in a freshwater bay contaminated with industrial waste and domestic sewage and in a freshwater pond. Escherichia coli, Klebsiella pneumoniae, Salmonella thompson, Streptococcus faecalis, and Serratia marcescens were the bacteria used. The survival times for these bacteria were lengthy (>77 days) under either summer or winter conditions. Thus, the use of seasonal effluent disinfection might eventually result in bacterial contamination of downstream sediments and possibly of waters overlying these sediments. As a result of certain disturbances, these bacteria could be recycled throughout the water column and eventually into man or animals directly or indirectly through potable water supplies. Sewage must be disinfected throughout the year if receiving waters are to have any commercial or recreational value or are to be a safe source of potable water. (Moore-IVI)
W84-01804

ASSESSING THE SUITABILITY OF SOILS WITH MACROPORES FOR SUBSURFACE LIQUID WASTE DISPOSAL,
Stichting voor Bodemkartering, Wageningen (Netherlands).
J. Bouma, C. Belmans, L. W. Dekker, and W. J. M. Jeurissen.
Journal of Environmental Quality, Vol. 12, No. 3, p 305-311, July-September, 1983. 7 Fig, 28 Ref.

Descriptors: *Macropores, *Soil porosity, *Subsurface waste disposal, *Land disposal, Permeability coefficient, Simulation, Computer models, Ponding, Drainage, Soil breakthrough, Soil crust, Soil saturation.

The capacity of soils to accept and purify liquid waste can be manipulated by using different application regimes. The associated transient soil physical conditions, which govern purification processes, were measured experimentally in soil columns and in situ, and were predicted by simulation in three soils of which two had macropores. Measurements of pressure heads, outflow rates, and breakthrough curves were made following intermittent liquid applications of 2 cm/d. Rapid breakthrough and short-circuiting, which were observed in the soils with the macropores, could be reduced by adding a light crust. Predictions involved computer simulation of pressure heads during infiltration and redistribution, and of outflow rates in the columns. Good agreement was found between measured and calculated values, but only when the model for soils with macropores was modified to include a subprogram for macropore flow. Simulation required hydraulic conductivity (K) at and near saturation, which was obtained with a modified crust test procedure. Use of the simulation program allows the prediction of soil physical conditions for a range of application rates in terms of ponding times and drainage rates, which affect purification and clogging. Measurement of breakthrough curves yields travel times as a function of application rates. Optimal application rates can be estimated by considering these two types of data, as is illustrated with an example. This approach is preferred over the current procedure using a single hydraulic parameter. (Author's abstract)
W84-01805

ANAEROBIC TREATMENT OF RAW DOMESTIC SEWAGE AT AMBIENT TEMPERATURES USING A GRANULAR BED UASB REACTOR,
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
G. Lettinga, R. Roersma, and P. Grin.
Biotechnology and Bioengineering, Vol. 25, No. 7, p 1701-1723, July, 1983. 5 Fig, 7 Tab, 19 Ref.

Descriptors: *Biological wastewater treatment, *Anaerobic digestion, *Domestic waste, Temperature effects, Sludge, Wastewater treatment, Chemical oxygen demand.

Results obtained in a 120 liter 2 m high upflow anaerobic sludge blanket reactor with raw domestic sewage and using a granular sugar beet waste cultivated seed sludge, reveal the feasibility of this type of anaerobic treatment of domestic sewage. Under dry weather conditions 65-85% COD reduction can be achieved at temperatures in the range of 8-20 degrees C and at hydraulic loads as high as 2 cu m/cu m/day. In the case of heavy rainfall the COD-reduction drops to 50-70% and occasionally, at very low influent COD, even below 50%. The net methane production amounts to 7.1-7.3 cu m/population equivalent/year, and the excess sludge production ranges from 5.0-8.6 kg total solids/population equivalent/year. Anaerobic treatment of raw sewage not only appears to

be an attractive proposition for tropic areas but also for moderate climatic areas. Generally the anaerobic treatment step should be followed by some adequate post-treatment in order to meet the restrictions set for discharge of effluents into receiving waters. (Baker-IVI)
W84-01817

BIOTECHNOLOGY IN THE WATER INDUSTRY,
Water Research Centre, Stevenage (England).
A. J. Vincent.
Water Services, Vol. 87, No. 1050, p 346-349, August, 1983. 5 Fig, 58 Ref.

Descriptors: *Biological treatment, *Bacteria, *Oxidation, Wastewater treatment, Organic matter, Domestic wastes, Nitrates, Ammonia, Methane, Anaerobic digestion, Aerobic treatment.

Biotechnology is not a new field, having been used in the water industry for a number of years in the processes of activated sludge, biological filtration and anaerobic digestion. These processes are cheap and effective and any radically different new processes would need to be shown to have major cost or performance benefits. Biological wastewater treatment processes use naturally occurring processes and employ natural selection of microorganisms arriving with the sewage to achieve the desired end. The microorganisms of most importance is the bacterium although protozoa play a vital role in clarification of effluent and higher organisms are essential in the ecology of the percolating filter. The biochemical reactions that the bacteria carry out include oxidation of organic matter to carbon dioxide and water, oxidation of ammonia to nitrate, oxidation of nitrite to nitrate, reduction of nitrates to nitrogen, conversion of organic matter to acetic acid, hydrogen and carbon dioxide, and conversion of acetic acid, hydrogen and carbon dioxide to methane. (Baker-IVI)
W84-01878

TREATMENT OF LOW STRENGTH DOMESTIC WASTEWATER USING THE ANAEROBIC FILTER,
Standard Oil Co. (Ohio), Cleveland.
H. A. Kobayashi, M. K. Stenstrom, and R. A. Mah.
Water Research, Vol. 17, No. 8, p 903-909, 1983. 7 Fig, 2 Tab, 24 Ref. Univ. of California Appropriate Technology Program grant 78-9-5000.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Anaerobic filter, Domestic wastewater, Biochemical oxygen demand, Suspended solids, Methane, Sulfides, Ammonia.

A laboratory scale anaerobic filter packed with synthetic high surface area trickling filter media was used to treat a low strength domestic wastewater averaging 288 mg/l COD. The filter was operated for 60 days after reaching steady-state at 20, 25, 35 C at a loading rate of 0.02 lb COD/cu ft/day and 24 h hydraulic retention time. Filter effluent BOD 5 averaged 38 mg/l providing an average removal rate of 79%, and effluent COD averaged 78 mg/l, corresponding to a 73% removal rate. Removal efficiencies showed very little sensitivity to daily fluctuations in influent wastewater quality. The filter performance at 25 and 35 C was not significantly different, but BOD and TSS removal efficiency declined at 20 C. Gas production averaged 0.027 cu ft of gas per cu ft of influent wastewater, or 1.875 cu ft of gas per pound of influent COD. Gas composition averaged 30% nitrogen, 65% methane, and 5% carbon dioxide. Ammonia nitrogen and sulfides both increased during treatments. It is concluded that the anaerobic filter is a promising candidate for treatment for low strength wastewaters and that post treatment for sulfides and ammonia may be necessary. (Author's abstract)
W84-01902

TERTIARY TREATMENT OF MUNICIPAL WASTEWATER BY CYPRESS DOMES,
Florida Inst. of Tech., Melbourne. Dept. of Environmental Sciences and Engineering.
F. E. Dierberg, and P. L. Brezonik.
Water Research, Vol. 17, No. 9, p 1027-1040, September, 1983. 9 Fig, 2 Tab, 27 Ref.

Descriptors: *Cypress domes, *Wastewater treatment, Municipal waste, Nitrogen, Phosphorus, Organic matter, Minerals, Dissolved oxygen, Tertiary wastewater treatment.

The feasibility of using cypress domes as an alternative to physical-chemical methods for tertiary treatment of sewage effluent was demonstrated over a 5 year period. Compared to effluent concentrations, rather small reductions, less than 33%, occurred in the concentrations of nitrogen, phosphorus, BOD, sodium, potassium, chloride, and fluoride in the surface waters of domes receiving treated sewage effluent. Larger reductions or about 50% occurred for calcium, magnesium and sulfate. The conventional treatment plant/oxidation pond itself was effective in reducing levels of BOD and total nitrate, but was ineffective in reducing levels of total phosphate and other minerals. The effectiveness of cypress domes in removing high percentages (greater than 90%) of organic matter, nutrients and minerals is more obvious when concentrations of these substances in the shallow watertable aquifer below the sewage-enriched domes are examined. Concentrations of these parameters in shallow wells in and around the sewage domes were at background levels throughout the study. High chloride values indicated that treated sewage was percolating into the shallow aquifer. Cypress domes and their associated sediments and soils thus can reduce the levels of major water quality parameters to levels comparable to those of conventional tertiary treatment processes. Sediments and vegetation continued to release inorganic ions to the standing water for more than 20 months after the cessation of sewage inputs. Parameters associated with organic matter and with the reducing environment of the sewage-enriched domes displayed a rapid return to background levels. (Baker-IVI)
W84-01907

NITRIFICATION BACK ON TRACK,
GRW Engineers, Lexington, KY.
D. L. Ralston.
Water Engineering and Management, Vol. 130, No. 7, p 29-30, July, 1983. 1 Fig.

Descriptors: *Wastewater treatment, *Nitrification, Sludge disposal, Activated sludge processes.

Continuous and conventional control practices proved to be sufficient to solve nitrification problems at an Ohio wastewater treatment plant. The Fairfield facility is a 6-mgd activated sludge plant with tertiary filtration and anaerobic digestion. Problems centered around the inability of the plant to meet NPDES requirements for ammonia nitrogen during the six summer months that the 2.5 mg/l effluent NH3-N limit is in effect. Problem areas identified included operator knowledge of the nitrification process and operational control techniques for solids handling; recycling of stream management; flow distribution to multi-basin unit processes; application of laboratory data to plant control, regulation of industrial discharges to prevent toxic influent slugs; and inclement weather sludge disposal. Correction of these problems lead to a satisfactory solution. (Baker-IVI)
W84-01913

GROWING A NEW TREATMENT PLANT FROM OLD ROOTS,
Camp, Dresser and McKee, Inc., Atlanta, GA.
C. S. Wilder, and G. Johnson.
Water Engineering and Management, Vol. 130, No. 10, p 28-31, September, 1983. 8 Fig.

Descriptors: *Water treatment facilities, *Water pollution control, Rivers, Georgia, Atlanta, South River, Jackson Lake, South River Basin, River basins.

The upgrading and expansion of the South River Wastewater Treatment Facility is a project which has practically cut a very old plant back to its root to allow a modern facility to arise in efforts to clean up the three rivers that flow through Atlanta. Wastewater discharges from plants in Atlanta and DeKalb County, and the city's three major combined sewer overflows are severely polluting the South River. The South River plant was originally designed in 1936 for an average daily flow of 6 mgd with primary settling, low-rate trickling filters, final settling and effluent chlorination. The multiple-project designed for the Three Rivers area will, when completed, comprise a 37 mgd South River Wastewater Treatment Plant which nitrifies the Intrenchment Creek Plant effluent and provides complete treatment for the previous influent to the Flint River Plant. Modifications are called for to the existing 20 mgd Intrenchment Creek Plant including effluent pumping facilities for discharge to the South River Plant for nitrification. The existing 6-mgd Flint River Plant will be replaced by a pump station for discharging raw wastewater to the South River Plant for treatment. A diversion system will provide a gravity sewer connection to transfer South River Plant effluent to the Chattahoochee River, and two combined sewer overflow facilities will be established with partial treatment to reduce the pollution load in receiving waters in the Three Rivers Program area during certain rainfall conditions. (Baker-IVI)
W84-01917

EXPERTS DISCUSS PRIVATE SECTOR INFILTRATION/INFLOW.
Water Engineering and Management, Vol. 130, No. 10, p 32-42, September, 1983.

Descriptors: *Infiltration, *Water treatment facilities, Wastewater treatment, Management, Decision making.

Most of the national emphasis on infiltration and inflow (I and I) source rehabilitation has been associated with public sector sewers. While this is certainly important, private sector I and I can also be significant. I and I in sanitary sewer systems can affect treatment plant compliance, cause sewer backups and overflows, require excessive expenditures for oversized treatment plants, and bring about no-growth conditions. A panel of four experts has agreed that identification and correction of private sector I and I can be implemented as part of a total sewer rehabilitation program. Special procedures may be needed, consisting primarily of public education and enforcement of municipal utility ordinances. Significant I and I flow reduction may not be possible if the private sector is not addressed. Political and legal issues may have an effect on the ultimate success of the private sector program in various communities. Clarification of existing regulations is required in some places. Managers in charge of other sewer rehabilitation programs across the country should consider the potential impact of all I and I sources on the sewer system - public and private. (Baker-IVI)
W84-01918

TIGHT EFFLUENT SPECS MET WITH DIGITAL CONTROL,
Upper Occoquan Sewage Authority, Centreville, VA.
M. H. Robbins, Jr.
Water Engineering and Management, Vol. 130, No. 11, p 30-36, October, 1983. 2 Fig, 1 Tab.

Descriptors: *Water treatment facilities, *Computers, Regulations, Standards, Wastewater treatment, Occoquan Policy, Virginia.

The Occoquan Policy formulated in Virginia in 1971 called for the construction of an advanced wastewater treatment plant, controlled largely by a computer-aided system. To ensure reliable performance, the facilities incorporate many failsafe features. Both the plant and the collection system are designed so that a single failure of a mechanical or electrical component will not interrupt operations essential in meeting the effluent requirements. The instrumentation and control system has four levels of control: manual, analog hardware, direct digital, and direct digital with analog backup. The instrumentation and control system

has been an important contributor to the success of the facility. (Baker-IVI)
W84-01919

WASTE WATER COMBUSTION IN A CONFINED SWIRL FLAME,
Duisburg Univ. (Germany, F.R.).
P. Roth, and R. Shamekhi.
Chemical Engineering Science, Vol. 38, No. 7, p 1101-1106, 1983. 8 Fig, 17 Ref.

Descriptors: *Wastewater treatment, *Nitrogen compounds, *Combustion, Industrial wastewater, Thermochemical conversion, Ammonia, Aminoethanol, Caprolactam, Evaporation, Nitrogen oxides, Water reuse.

In some industrial production processes water with dissolved or dispersed organic or inorganic chemical compounds is originated which cannot be biologically treated. One possible way of recycling is high temperature thermochemical conversion in flames. Particular problems are caused by waste water which contains nitrogen compounds. Water with the dissolved N-compounds ammonia, aminoethanol and epsilon-caprolactam (NH3, C2H7NO and C6H11NO) was sprayed into a confined swirl flame operating under various conditions. The model waste water and the atomizing fluid influence the visible flame structure. The rates of mixing and evaporation in the recirculation zone of the combustor flow are high enough to make the droplets quickly vanish. The water dissolved N compounds are assumed to be fully present in the gas phase. The NO yield can be predicted by using Fenimore's empirical correlation function derived from measurements on fuel-N conversion of premixed flames. This fundamental relationship seems to be applicable for very complex combustion situations and in an engineering sense can be used to predict the N conversion factor. (Moore-IVI)
W84-01993

WETLANDS FOR WASTEWATER TREATMENT,
J. Benforado.
EPA Journal, No. 2, p 14-15, October, 1983. 2 Fig.

Descriptors: *Wetlands, *Wastewater treatment, Water plants, Walt Disney World, Florida, San Diego, California.

An aquaculture project funded by the city of San Diego is part of a pilot test advanced treatment facility that treats raw sewage to standards higher than those used for tap water in many cities. Lagoons filled with water hyacinths are used to clean the water. Similar installations ar%;Y at NASA labs at Bay St. Louis, Miss., and at Walt Disney World, Orlando, Florida. In the latter location waste discharge is first given a high degree of secondary treatment and is then treated by one of four different methods. The major portion of effluent is discharged to a cypress swamp, another portion is used for spray irrigation, and overflow from ponds is sent through a cattail marsh. A water hyacinth system has also been constructed for experimental use. In addition to providing waste treatment, managed wetlands can also contribute many other benefits including offering sanctuary to migrating birds. Wetlands purify wastewater through physical entrapment of pollutants in the surface soils and organic litter. (Baker-IVI)
W84-02000

EFFECT OF MEMBRANE MATERIALS AND AVERAGE PORE SIZES ON REVERSE OSMOSIS SEPARATION OF DYES,
National Research Council of Canada, Ottawa (Ontario). Div. of Chemistry.
L. Tinghui, T. Matsuura, and S. Sourirajan.
Industrial and Engineering Chemistry, Product Research and Development, Vol. 22, No. 1, p 77-85, 1983. 3 Fig, 7 Tab, 32 Ref.

Descriptors: *Reverse osmosis, *Dyes, *Membrane processes, Wastewater treatment, Dye industry wastes, Liquid chromatography.

Reverse osmosis separations of 13 dyes were conducted by using cellulose acetate and aromatic polyamidohydrazide membranes of various average pore sized at operating pressures in the range 689 to 1723 kPag. High performance liquid chromatography (HPLC) experiments were also performed with respect to all dyes studied using chromatography columns filled with powders of membrane polymer materials. Interfacial force constants A, B, and D, which are associated with the electrostatic force, van der Waals force, and steric hindrance, respectively, were generated by applying the transport equations to the data from reverse osmosis and HPLC experiments. The interactive forces depend on the chemical structure of the dye molecule and the membrane material, when solvent is fixed as water. They are primarily governed by the net electric charge, polar and nonpolar organic functional groups of dye molecules, and by the acidity-basicity nature of the membrane materials. The force constants enable the prediction of the dye solute separation for a given average pore radius of the membrane. This provides a basis for the choice of membrane materials for use in reverse osmosis applications involving separation of dyes in aqueous solutions, such as the treatment of dye-laden wastewaters. (Moore-IVI)
W84-02009

WASTEWATER TREATMENT - AN AWARD-WINNING SYSTEM,
Amoco Chemicals Corp., Joliet, IL.
G. P. Chodil.
Hydrocarbon Processing, Vol. 62, No. 10, p 61-64, October, 1983. 5 Fig, 1 Tab.

Descriptors: *Wastewater treatment, *Industrial wastes, Activated sludge process, Aeration basins, Filtration, Lagoons, Joliet, Illinois.

The Joliet, Illinois facility's wastewater treatment facility is an activated sludge plant consisting of primary basins for equalization of feed surges; aeration basins for biological oxidation of dissolved organics; clarifiers for solids/liquids separation; and polishing facilites including dissolved air flotation, ponds and filters for final treatment of the effluent before discharge to the Des Plaines River. The Amoco plant itself has a production capacity of 500 million pounds per year of raw materials for polyester fiber and film and polystyrene industries. The organic acid content of the wastewaters from the plant results in a total organic carbon concentration of 3,000-4,000 mg/l and a pH of about 4. About 0.5 MMgal per day of these high strength organic acid wastewaters are treated in an activated sludge process before final discharge. (Baker-IVI)
W84-02014

IMPROVE PLANT WATER QUALITY,
Du Pont de Nemours (E.I.) and Co., Beaumont, TX.
W. W. Carden.
Hydrocarbon Processing, Vol. 62, No. 10, p 75-77, October, 1983. 3 Fig, 1 Tab, 2 Ref.

Descriptors: *Water treatment, *Industrial water, *Polyelectrolytes, Coagulation, Clarifiers, Sedimentation, Turbines, Fouling, Beaumont, Texas.

Producing high quality water for various in plant uses is of prime concern as long as the processes used are reliable and cost effective. Synthetic organic polyelectrolytes have been used effectively instead of the inorganic coagulants by DuPont's Beaumont (Texas) plant. The plant had used alum/activated silica as coagulant materials for many years. The switch to polyelectrolyte coagulant materials for influent water clarification enabled the plant to meet its more stringent water quality criteria and eliminate the adverse effect of alum treatment. Simple sedimentation has been enhanced through employment of the principles of stabilizing suspensions. Clarification of water is accomplished by two basic mechanisms: electrokinetic coagulation in which the electrostatic charge is neutralized, and orthokinetic coagulation in which the high molecular weight molecules bridge the microflocs into larger, faster settling particles. An adjustment has also been made in the turbine which has reduced significantly the tendency for solids buildup. The elimination of alum fouling has enables the manufacturing facility to avoid production curtailment formerly caused to heat exchanger fouling and to eliminate one five-day annual outage for heat exchanger cleaning. (Baker-IVI)
W84-02016

ANAEROBIC WASTEWATER TREATMENT SYSTEM HANDLES HIGH-STRENGTH INDUSTRIAL WASTE,
Celanese Chemical Co., Bishop, TX. Process Engineering Dept.
L. M. Harvey, and J. C. Rubiano.
Paper Trade Journal, Vol. 167, No. 6, p 28-30, March 30, 1983. 1 Fig, 2 Tab.

Descriptors: *Anaerobic digestion, *Wastewater treatment, Industrial wastewater, Hydrogen ion concentration, Heavy metals, Chemical oxygen demand.

The Celrobic Wastewater Treatment System in operation at the Celanese plant at Bishop, Texas was designed to meet projected plant wastewater treatment needs through 1989. The system has demonstrated a high degree of flexibility for treating liquid effluents with widely varying pH or concentrations of COD or heavy metals. The addition of the anaerobic reactor upstream of the plant's existing activated sludge system has made possible the treatment of process effluent streams which could not be treated in conventional aerobic systems. The addition of the Celrobic Wastewater Treatment System has increased not only the capacity but also the reliability of the wastewater treatment system at the plant. Improved reliability and economic advantages of methane gas credits and reduced sludge production have proven the retrofit of the Celrobic System to the existing activated sludge system to be the superior alternative for expanding the wastewater treatment facilities at the Bishop Plant. (Baker-IVI)
W84-02047

PHOSPHORUS AND BACTERIA ELIMINATION IN A SEWAGE TREATMENT PLANT WITH A FOURTH PURIFICATION STAGE (WEITESTGEHENDE PHOSPHOR- UND BAKTERIENENTFERNUNG IN EINER KLARANLAGE MIT IV. REININGUNGSSTUFE),
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
R. Mosimann, and F. Schanz.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 5, p 161-167, 1983. 7 Fig, 3 Tab, 17 Ref.

Descriptors: *Tertiary wastewater treatment, *Phosphorus removal, *Coliforms, *Enteric bacteria, Uster, Switzerland, Storm runoff, Rainfall, Wastewater treatment, Sludge basins.

The degree to which phosphorus is eliminated in a sewage treatment plant with a fourth purification stage and the the extent of retention of fecal bacteria (coliform bacteria and enterococci) by the sewage works are considered. The sewage treatment plant chosen for this study is situated in Uster (canton of Zurich, Switzerland). In dry weather, the plant was able to eliminate 96% of total phosphorus; however only 21% of the measured outflow values lay at or below the prescribed value of 0.2 mg total P/l. During a period of rain, even strongly increased amounts of solid waste, such as are swept from roofs, streets and drains, are retained in the fourth purification stage. This contrasts with sewage treatment plants having only two or three purification stages, where considerable amounts of sludge are deposited in the receiving watercourse. As a result of the increased rates of flow and the corresponding short residence time in the sludge basins, a strong increase is observed in the amount of phosphorus in the outflow during the period of rain, in comparison to the conditions existing during dry periods. The fecal bacteria were found to be 92% retained by the fourth stage alone. The final concentration of fecal bacteria in the purified wastewater amounts to only about

0.3% of that in the raw sewage entering the plant. (Author's abstract)
W84-02075

APPLICATION OF IR-SPECTROSCOPY IN THE DEGRADATION OF ORGANIC SUBSTANCES; REPORT III. CATION TENSIDES (EINSATZ DER IR-SPEKTROSKOPIE BEIM ABBAU ORGANISCHER STOFFE; III. MITTEILUNG: KATIONTENSIDE),
Bundesanstalt fuer Gewaesserkunde, Coblenz (Germany, F.R.).
H. Hellmann.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 5, p 174-179, 1983. 14 Fig, 8 Ref.

Descriptors: *Wash water, *Wastewater treatment, *Degradation, *Cation tensides, Domestic wastes, Laundering, Clay.

Cation tensides in the form of distearyldimethylammoniumchloride are applied as active component in softening agents in domestic use and industrial laundries. Owing to their great affinity to solid surfaces, in particular to clay minerals, physical-chemical elimination in addition to biochemical degradation in sewage treatment plants is to be expected. The model experiment pursues the degradation of k-tensides beyond the potential 'elimination', analogous to the degradation of a- and n-tensides and non-tensides detergent components in Rhine water, and, where possible, assesses and identifies intermediate products of the degradation. (Author's abstract)
W84-02076

SYNTHESIS OF ION-EXCHANGE MEMBRANES FOR ELECTRODIALYTIC TREATMENT OF INDUSTRIAL EFFLUENTS,
Indian Inst. of Tech., Bombay. Dept. of Cemistry.
B. Chakravorty, R. N. Mukherjee, and S. Basu.
Desalination, Vol. 46, p 353-360, 1983. 2 Fig, 3 Tab, 4 Ref.

Descriptors: *Desalination, *Ion exchange, *Electrodialysis, Membrane processes, Water pollution control, Reclaimed water, Metal-finishing wastes, Industrial wastewater.

Heterogeneous ion-exchange membranes have been synthesized by grafting styrene on neutral polyethylene films, using a high energy cobalt-60 radiation source. The cationic and anionic groups were subsequently introduced by sulfonation and chloromethylation followed by amination, respectively. Physical and electrochemical properties of the membranes were found to be suitable for utilization in electrodialytic treatment of industrial effluents. Electrodialysis (ED) was carried out using synthesized membranes in a three compartment ED cell to study the techno-feasibility of this process for pollution abatement along with reclamation of water and precious metals. (Author's abstract)
W84-02088

FOULING STUDIES AND MATHEMATICAL MODELLING OF ULTRAFILTRATION OF TEXTILE DESIZING EFFLUENTS,
Mekoroth Water Co., Tel Aviv (Israel).
C. A. Buckley, R. L. C. Flemmer, and G. R. Groves.
Desalination, Vol. 47, p 171-179, 1983. 4 Fig, 6 Ref.

Descriptors: *Membrane processes, *Ultrafiltration, *Textile mill wastes, *Wastewater renovation, Model studies, Mathematical studies, Cost analysis, Textile desizing.

The permeate flux from a spiral-wrap ultrafiltration membrane is a complex function of inlet pressure, reject flowrate, polymer concentration and degree of membrane fouling. A mathematical model is presented that describes the permeate flux before and after the onset of gel-polarization. The use of the model in evaluating the effects of membrane fouling and cleaning strategies on plant performance is discussed with reference to polyvinyl alcohol textile size recovery. The two main effects which determine the permeate flux of a clean membrane are the transmembrane driving force and the formation of a polymer gel-layer adjacent to the membrane. For very dilute solutions the permeate flux increases with the average transmembrane pressure, which is at a maximum when the reject valve is closed and decreases as the reject flowrate increases. For solutions which form gel-layers, the permeate flux is limited because the formation of a gel-layer implies that the process becomes diffusion controlled. An increase in the reject flowrate decreases the thickness of the gel-layer resulting in an increase in flux. The model assumes that for any particular position along a membrane element, conditions will either be those of gel-polarization or such that the eddies in the reject flow will be adequate to scour the surface. From a network analysis, the optimal configuration of membrane elements shows that significant savings in membrane area and pumping costs are achievable. (Baker-IVI)
W84-02106

MEMBRANE FILTRATION FOR THE REUSE OF CITY WASTE WATER,
Danske Sukkerfabrikker, Nakskov. Reverse Osmosis Div.
O. J. Olsen, and U. H. Haagensen.
Desalination, Vol. 47, p 257-265, 1983. 6 Fig, 3 Tab, 5 Ref.

Descriptors: *Desalination, *Filtration, *Membranes, Membrane processes, Ultrafiltration, Municipal wastes, Wastewater treatment, Reverse osmosis, Wastewater renovation.

Membrane filtration represents a feasible alternative for recovery and upgrading of municipal wastewater. A secondary municipal effluent from a plant with a combined mechanical-aerated pond treatment was treated by ultrafiltration. The ultrafiltration performed satisfactorily over a testing period of two and a half months. An economic evaluation of the process shows that the operational costs and the capital costs amount to about 0.5 US dollars per cubic meter of filtrate. Reverse osmosis operation showed that a large improvement in capacity could be obtained by pretreatment of the effluent by ultrafiltration compared to untreated effluent. However, it is obvious that ultrafiltration as a pretreatment method general!y does not solve the fouling problem found in the reverse osmosis operation. It is anticipated, nevertheless, that wastewater from plants with higher cleaning efficiency will lead to improved reverse osmosis operations. The characterization of secondary effluent is complex and the performance of reverse osmosis will be to a large extent based on a number of unknown factors in connection with chemical composition of the water and efficiency of the sewage treatment plant. (Baker-IVI)
W84-02109

APPLICATION OF MEMBRANE SEPARATION PROCESSES TO THE TREATMENT OF INDUSTRIAL EFFLUENTS FOR WATER REUSE,
Natal Univ., Durban (South Africa). Dept. of Chemical Engineering.
G. R. Groves.
Desalination, Vol. 47, p 277-284, 1983. 1 Fig, 3 Tab, 4 Ref.

Descriptors: *Desalination, *Wastewater treatment, *Membrane processes, Reverse osmosis, Water quality control, Waste disposal, Water reuse, Wastewater renovation, Industrial wastewater.

The discharge of industrial effluents into the water environment is being made more difficult through environment pollution regulations passed to preserve water quality. The applicability and scope of membrane technology for treatment of industrial effluents is gaining ground. The membrane separation techniques, and in particular reverse osmosis, have tremendous potential due to their ability to remove organic and/or inorganic compounds in a one-step process at a reasonable cost. The main problem is the susceptibility to fouling by insoluble salts and certain organic compounds. The major considerations for the application of membrane technology to the treatment of industrial effluents are pretreatment, membrane type, module type and configuration, cleaning requirements, rejection performance and economics. When considering the disposal of the final concentrates from membrane treatment plants, reverse osmosis plants may be considered as concentrating devices for the production of concentrates of total solids in the range of 60-100 g/l, depending on the osmotic backpressure and maximum module operating pressure. For most treatment of industrial effluents, the membrane flux rates will be fairly low and hence reverse osmosis plants cannot be designed on an once-through basis. This is overcome by interstage recycling on series-taper plants or by using batch concentration. Cost effectiveness is improved with increasing membrane production volumes and enhanced reliability of membrane treatment plants. (Baker-IVI)
W84-02110

REVERSE OSMOSIS TREATMENT AND REUSE OF TEXTILE DYEHOUSE EFFLUENTS,
Natal Univ., Durban (South Africa). Dept. of Chemical Engineering.
K. Treffrey-Goatle, C. A. Buckley, and G. R. Groves.
Desalination, Vol. 47, p 313-320, 1983. 2 Fig, 2 Tab, 7 Ref.

Descriptors: *Wastewater removation, *Dye industry wastes, *Reverse osmosis, Membrane processes, Filtration, Water reuse, Color.

A 30 cubic meter/d pilot plant consisting of screening, alum coagulation, microfiltration and reverse osmosis was operated for 2 years on cotton/nylon/polyester dyehouse effluents. The reverse osmosis modules used were the brackish and seawater UOP PA300 type. The pilot plant operated at water recoveries of 85-95% and temperatures of 30-45 degrees C. The microfiltration unit was used to remove suspended solid and colloidal dyestuffs from the effluent prior to the spiral-wrap membranes. The average permeate flux was 15 l/sq m/hour. The average permeate quality was 60 mg/l of total dissolved solids, 15 mg/l of sodium, 11 mg/l of TOC and 21 ADMI color units. The product water was reused routinely for production dyeing. While fairly severe membrane fouling occurs, it has been controlled through regular cleaning of the membranes. (Baker-IVI)
W84-02111

MAKE-UP WATER TREATMENT AT THERMAL POWER PLANTS AND MULTIPLE WASTE WATER RE-USE,
O. I. Martynova, A. I. Abramov, A. S. Sedlov, L. G. Vasina, and I. P. Iljina.
Desalination, Vol. 47, p 321-325, 1983. 2 Fig, 1 Tab, 3 Ref.

Descriptors: *Demineralization, *Powerplants, *Wastewater treatment, Water reuse, Ion-exchange, Evaporation, Make-up water, USSR.

Currently, demineralization of make-up water for the compensation of steam and condensate losses at thermal power stations is carried out mainly by ion exchange. Substantial ecological advantages can be achieved through the use of thermal water treatment with evaporators. At some thermal powerplants in the USSR boiling type evaporators are fed with sodium-cation exchange softened water to get demineralized make-up water. Thermal demineralization using sodium cationized water makes it theoretically possible to minimize wastewater salt content, if it is used repeatedly for sodium cationite filters regeneration. (Baker-IVI)
W84-02112

TREATMENT OF PULP/PAPER BLEACH EFFLUENT BY REVERSE OSMOSIS,
Sappi Ltd., Enstra (South Africa). Dept. of Research and Development.
M. J. Simpson, and G. R. Groves.
Desalination, Vol. 47, p 327-333, 1983. 4 Fig, 5 Tab, 6 Ref.

Descriptors: *Reverse osmosis, *Bleaching wastes, Pulp wastes, Industrial waste, Wastewater treatment, Bleaching wastes, Pulp and paper industry, Membrane processes.

The reverse osmosis treatment of bleach effluents from pulp and paper manufacturing is becoming of increasing importance because of environmental considerations. Investigations on the treatment of bleach effluent with three thin-film composite reverse osmosis membranes are presented. Membrane fouling was significant and was only partially controlled by the manufacturers recommended cleaning procedures. The three membranes tested were: Filmtech brackish water FT30 in a 100 mm diameter spiral-wrap module (type BW30-40-14); UOP brackish water PA300 in a 100 mm diameter spiral-wrap module (type 4600PA); and DDS brackish water HR95 in flat-sheet form. Membrane rejections were above 90% for both inorganic and organic components, for a total solids range of 5-30 g/l. While thin-film composite membranes have good rejections of the organic components of bleach effluents, the membrane fluxes are unacceptably low for the direct treatment of the effluent. (Baker-IVI)
W84-02113

STUDIES ON THE APPLICATION OF RO IN TREATMENT OF RAYON PLANT EFFLUENT,
Indian Inst. of Tech., Bombay. Dept. of Chemical Engineering.
S. Basu, and S. Moulik.
Desalination, Vol. 47, p 335-342, 1983. 5 Fig, 13 Ref.

Descriptors: *Reverse osmosis, *Textiles, Rayon, Industrial wastes, Water reuse, Turbulent flow, Laminar flow, Wastewater treatment, Wastewater renovation, Water pollution control.

Reverse osmosis is evaluated for the treatment of spinning bath and washing effluent stream for water/chemicals reclamation, along with pollution abatement. Initial membrane evaluation was carried out in a reverse osmosis test loop having 1 mm feed channel height and 0.60 sq cm flow cross sectional area with cellulose diacetate membrane, and thin film amide composite membrane (PA-300). Under varying flow rates concentration polarization modulus was pronounced at low concentrations of sodium sulfate solution (2%), while it was lower at higher concentrations (12%). At higher flow rates, however, polarization modulus was more or less constant, varying between 1.075 to 1.10, depending on feed concentrations and type of membrane used. Mass transfer coefficients calculated from experimental results showed good agreement with predicted data. (Baker-IVI)
W84-02114

DESALINATION OF COALMINE DRAINAGE WATER BY REVERSE OSMOSIS,
Binnie and Partners, London (England).
For primary bibliographic entry see Field 3A.
W84-02115

STUDY OF EMULSIFIED LIQUID MEMBRANE TREATMENT OF PHENOLIC WASTE WATER,
Y. C. Chang, and S. P. Li.
Desalination, Vol. 47, p 351-361, 1983. 10 Fig, 2 Tab, 7 Ref.

Descriptors: *Phenols, *Wastewater treatment, *Membrane processes, Liquid membrane extraction, Chemical recovery.

The emulsified liquid membrane extraction technique is a new and effective method for separation of mixtures with applications in the nuclear industry, hydrometallurgy and wastewater treatment. The emulsified liquid membrane is made by forming an emulsion of two immiscible phases and then dispersing the emulsion in a third phase (i.e. continuous phase). Phenolic wastewater was treated containing 300-950 ppm of phenol with aqueous NaOH solution in an oil type liquid membrane. The treatments were performed in a batch permeater and a continuous counter-current extraction column respectively. In a batch operation, under suitable conditions, 98% of the phenol could be removed from phenolic wastewater and the rate of breakage of the emulsion drops was less than 1% per hour. The overall diffusivities of phenol through the liquid membrane are constant. A continuous counter-current liquid membrane extraction column (6.2 cm diameter, 120 cm long) was installed and its efficiency examined. The height of the theoretical stage of the liquid membrane extraction column was about 160-190 cm. If extraction of phenol from a waste water containing 500 ppm phenol was performed in a column with efficiency of one theoretical stage, more than 99% of phenol might be removed by such a liquid membrane process. (Baker-IVI)
W84-02116

5E. Ultimate Disposal Of Wastes

PROTECTING WATER SUPPLY AQUIFERS IN AREAS USING DEEP-WELL WASTEWATER DISPOSAL,
CH2M Hill Southeast, Inc., Gainesville, FL.
For primary bibliographic entry see Field 5G.
W84-01790

SEWAGE SLUDGE FOR CULTIVATING FRESHWATER ALGAE AND THE FATE OF HEAVY METALS AT HIGHER TROPHIC ORGANISMS; I. DIFFERENT METHODS OF EXTRACTING SEWAGE SLUDGE ON THE PROPERTIES OF SLUDGE EXTRACTS,
Hong Kong Polytechnic, Kowloon. Dept. of Applied Science.
F. Y. Tam, and M. H. Wong.
Archiv fur Hydrobiologie, Vol. 96, No. 4, p 475-485, April, 1983. 2 Fig, 1 Tab, 38 Ref.

Descriptors: *Sludge disposal, *Heavy metals, *Algal growth, Aquaculture, Recycling, Waste recovery.

The main aim of this project is to (1) recycle sewage sludge into an unconventional protein material through the cultivation of unicellular algae in water extracts of sewage sludge and (2) study the fate of heavy metals at higher trophic organisms by using the waste-grown algae in rearing other aquatic organisms. In the first part of the project, different methods were employed to extract sewage sludge. Autoclaving was the most effective method in recovering essential nutrients as well as heavy metals from sewage sludge, following by shaking; whereas homogenizing was the least effective. The pH value of the extractant was the main factor in determining the content of heavy metals in sludge extracts. The two extreme pH (2 and 12) yielded extracts with higher essential nutrients. The amount of heavy metals released was negatively correlated to the extractant pH. (Author's abstract)
W84-01845

WASTE CONCENTRATION VS EVAPORATION PONDS FOR REVERSE OSMOSIS REJECT WATER - A CASE STUDY,
Water Services of America, Inc., Milwaukee, WI.
G. F. Leitner.
Desalination, Vol. 44, p 31-38, 1983. 2 Fig, 4 Tab, 4 Ref.

Descriptors: *Reverse osmosis, *Evaporation ponds, *Brine disposal, Desalination, Water resources development.

With the almost universal acceptance of the reverse osmosis process for desalination of brackish waters and its resulting widespread use throughout the world, it becomes increasingly important to seek out ways for further cycle improvement. One area for improvement has been the avoidance of possible contamination of groundwaters through lining reject ponds with synthetic rubber or similar material to prevent seepage into the soil. New developments in the distillation field have resulted in reduced energy requirements for concentrating distillation units. These developments make it practical to consider using vapor compression distillation in combination with reverse osmosis plants for inland locations where lined ponds are required due to investment limitations. A case study of a water project is offered to determine if further concentration of the reject water by distillation would be a cost effective solution. (Baker-IVI)
W84-02022

5F. Water Treatment and Quality Alteration

REACTION RATES OF POLYNUCLEAR AROMATIC HYDROCARBONS WITH OZONE IN WATER,
Institut Rudjer Boskovic, Zagreb (Yugoslavia).
V. Butkovic, L. Klasinc, M. Orhanovic, J. Turk, and H. Gusten.
Environmental Science and Technology, Vol. 17, No. 9, p 546-548, 1983. 2 Fig, 1 Tab, 17 Ref.

Descriptors: *Polynuclear aromatic hydrocarbons, *Ozone, *Rate constants, Ozonation, Pyrene, Phenanthrene, Benzo(a)pyrene, Disinfection, Viral inactivation, Water treatment.

The rate constants for the reaction of pyrene, phenanthrene, and benzo(a)pyrene with ozone in water were determined by means of stopped-flow spectrometry. The second-order rate constants amount to about 40,000, 15,000, and 6,000 cu dm/mol/s, respectively, over the pH range 1-7. The corresponding half-lives in presence of 0.0001 M ozone at pH 7 are less than a second, i.e., they are 10,000 times shorter than the values for pyrene and benzo(a)pyrene that are dissipated widely in the literature. Since ozonation used for the bacterial disinfection and viral inactivation of drinking water usually affords ozone contact times of 4 min, one can expect that within this time and with an ozone dosage of about 1 mg/L, all of the polynuclear aromatic hydrocarbons will be oxidized completely. The rate constants may also be used for the prediction of half-lives of polynuclear aromatic hydrocarbons in the lower atmosphere. (Moore-IVI)
W84-01782

FROM DREAM TO REALITY: LAKE MICHIGAN WATER FOR FOUR CHICAGO SUBURBS,
PRC Consoer Townsend, Inc., Chicago, IL.
J. E. Callan.
Journal of the American Water Works Association, Vol. 75, No. 6, p 262-265, June, 1983. 1 Fig.

Descriptors: *Water supply development, *Legal aspects, *Lake Michigan, Water conveyance, Water quality, Water allocation, Illinois.

The Northwest Water Commission was organized to supply water to four cooperating suburban Chicago communities; Arlington Heights, Buffalo Grove, Palatine, and Wheeling. In the late 1950's water levels in the sandstone aquifer tapped by the cities' wells were declining from 3 to 6 m per year, resulting in higher pumping costs, high maintenance costs, and declining water quality. It became apparent that water would have to be obtained from an alternative source. Securing the legal right to use water from Lake Michigan took 25 years and involved a US Supreme Court ruling. The system is now under construction and will be in operation of 1984. The project consists of 72.4 km of water transmission mains, a 94-ML reinforced concrete reservoir, a 189-ML/d main pumping station, and a 283-ML/d booster pumping station. (Moore-IVI)
W84-01786

TETRACHLOROETHYLENE CONTAMINATION OF GROUNDWATER IN KALAMAZOO,
Kalamazoo City Dept. of Public Utilities, MI.
B. Minsley.
Journal of the American Water Works Association, Vol. 75, No. 6, p 272-279, June, 1983. 7 Fig, 5 Tab, 6 Ref.

Descriptors: *Groundwater pollution, *Tetrachloroethylene, *Water pollution sources, *Water pollution control, Test wells, Purge wells, Water distribution, Chlorinated hydrocarbons, Kalamazoo, Michigan.

Sampling of the Kalamazoo, Michigan, water supply showed 10 micrograms/L of tetrachloroethylene from an unknown source in a portion of the city's water distribution system and in one of the city's well fields. The contaminated well was immediately removed from service and pumped to waste. A land use study, a theoretical piezometric surface, and sequential well drilling techniques facilitated locating the source and determining the extent of the contamination. An abandoned dry cleaning business was found to be the source of the contamination. Using the two most contaminated production wells as purge wells has thus far been an effective means of protecting the remainder of the well field from further increases in tetrachloroethylene contamination. To reduce the likelihood of any other contamination reaching the central well field undetected, the utility has proposed that a complete well monitoring system be built around the central well field to serve as an early warning system. (Moore-IVI)
W84-01788

CONTAMINATED GROUNDWATER TREATABILITY - A CASE STUDY,
Environmental Engineering Consultants, Inc., Stillwater, OK.
E. L. Stover, and D. F. Kincannon.
Journal of the American Water Works Association, Vol. 75, No. 6, p 292-298, June, 1983. 5 Fig, 19 Tab, 5 Ref.

Descriptors: *Treatability, *Water treatment, *Groundwater pollution, Heavy metals, Organic compounds, Waste dumps, Aquifer restoration, Chemical precipitation, Steam stripping, Activated carbon, Adsorption, Biological treatment, Physicochemical treatment.

The contamination of groundwater by toxic organic chemicals is becoming a widespread concern in the United States. The once abundant supply of uncontaminated groundwater has diminished to the degree that treatment of contaminated groundwaters is being required for direct use and for aquifer restoration or reclamation. Removal of organic chemicals requires treatability studies to determine the proper treatment processes and the proper design of these processes. Treatability studies show that the volatile organics, extractable organics, and inorganics (heavy metals) of concern in the contaminated groundwater near a hazardous waste dump site can be treated successfully by two alternative processes. One process consists of chemical precipitation to remove metals, steam stripping, and activated carbon adsorption. The alternative process consists of combined physical-chemical and biological treatment. (Moore-IVI)
W84-01791

CHEMISTRY OF REDUCED SULFUR SPECIES AND THEIR REMOVAL FROM GROUNDWATER SUPPLIES,
Sargent and Lundy, Chicago, IL.
D. A. Dohnalek, and J. A. FitzPatrick.
Journal of the American Water Works Association, Vol. 75, No. 6, p 298-308, June, 1983. 16 Fig, 4 Tab, 50 Ref.

Descriptors: *Hydrogen sulfide, *Groundwater pollution, *Water treatment, Sulfide removal, Drinking water, Ferrous sulfate, Peroxides, Permanganates, Ferrates, Cost analysis.

The removal of hydrogen sulfide from groundwater supplies was investigated by using various catalysts and oxidants in bench-scale jar tests that simulated assumed actual conditions in a water treatment plant. Variations in aeration rate, chemical dosage, recycled solids, pH, and detention time were also examined. A ferrous sulfate dosage of 9 mg/L reduced sulfide concentrations to 0.05 mg/L, largely owing to the catalytic effect of Fe(II). Peroxide, permanganate, and ferrate also lowered the sulfide concentrations, with more rapid kinetics than Fe(II). An economic analysis showed that Fe(II) is a cost-effective alternative for sulfide removal. The other oxidants may also prove economical under certain conditions. (Author's abstract)
W84-01792

DETERIORATION OF WATER QUALITY IN LARGE DISTRIBUTION RESERVOIRS (OPEN RESERVOIRS).
Journal of the American Water Works Association, Vol. 75, No. 6, June, 1983. 4 Tab, 40 Ref.

Descriptors: *Water quality, *Reservoirs, Water storage, Seattle, Washington, Hackensack, New Jersey, Southern California, Monitoring, Bacteria, Phytoplankton, Turbidity, Algal growth, Temperature effects, Seasonal variations.

The quality of water in open, filtered-water reservoirs of three distribution systems was monitored in order to ascertain the degree to which water quality deteriorates during storage in the reservoirs. Data are presented from monitoring programs conducted in southern California, Seattle, Washington and Hackensack, New Jersey. In California the water quality parameters met the 1977 standards at all times and all locations. Turbidity occasionally increased to levels exceeding 1 tu. Trihalomethane levels varied but were frequently greater than the 100 microgram/liter standard established by the USEPA for drinking water. Substantial bacterial populations existed in the reservoirs. Algal populations grew to nuisance proportions several times during the study. Chemical airborne inputs do not appear to influence reservoir dynamics significantly, but bacteria may enter the reservoirs through airborne transport. Significant detrimental changes were noted in water quality after reservoir storage. While many significant interrelationships were found between the various parameters that were measured, no key parameters were found whose limitation might inhibit deterioration of water quality in the reservoirs. The difference between evaporation loss and precipitation gain in the reservoirs was relatively small. No significant differences in water quality were noted between various sites in the reservoirs. Seattle studies indicated no problems with phytoplankton but bacterial populations did contribute to water quality degradation in varying degrees, and some of the reservoirs clearly demonstrated an inadequate storage capacity. New Jersey studies showed turbidity levels increasing during warm months with algal populations being the main influence. Bacterial populations increased slightly with postchlorination maintaining a quality equivalent to that of water leaving the treatment plant. Nutrients such as nitrite, nitrate, phosphate and dissolved oxygen were not significantly affected by the open reservoirs. Trihalomethane levels varied as a function of the surface water supply. (Baker-IVI)
W84-01793

WASTEWATER REUSE: A RESOURCE OR A NUISANCE,
American Water Works Association Research Foundation, Denver, CO.
J. G. DeBoer.
Journal of the American Water Works Association, Vol. 75, No. 7, p 348-356, July, 1983. 4 Tab, 19 Ref.

Descriptors: *Water reuse, *Potable water, *Water treatment, Water quality, Water conservation, Wastewater renovation, Groundwater recharge, Reclaimed water.

As demand for good quality water increases, some areas in the United States find that traditional finite sources cannot meet all needs. Although many utilities draw potable supplies from water that has previously been used upstream, the direct reuse of treated water for potable supplies is limited by unknowns concerning health effects and by costs. Planned reuse options, however, are feasible water conservation techniques, especially for industrial and agricultural uses. Reclaimed wastewater can also be used to recharge groundwater, thereby augmenting potable supplies. (Author's abstract)
W84-01799

COLIFORM OCCURRENCE AND CHLORINE RESIDUAL IN SMALL WATER DISTRIBUTION SYSTEMS,
Drexel Univ., Philadelphia, PA. Dept. of Biological Sciences.
M. A. Goshko, W. O. Pipes, and R. R. Christian.
Journal of the American Water Works Association, Vol. 75, No. 7, p 371-374, July, 1983. 1 Fig, 5 Tab, 15 Ref. EPA grant R-805637.

Descriptors: *Residual chlorine, *Coliforms, *Water distribution systems, Escherichia coli, Enterobacter, Klebsiella, Chlorination, Disinfection.

Samples were collected from seven small (0.09-11 ML/d) municipal water systems. Statistical analyses showed that for systems in which the free chlorine residuals vary considerably, there is no association between coliform density and a free chlorine residual of <0.2 mg/L. Enterobacter cloacae and Enterobacter agglomerans were found in samples with a free chlorine residual >0.2 mg/L, whereas Escherichia coll was found only in samples without a free chlorine residual. Some other coliforms species were found at the higher chlorine residuals; however, at all but one site they were found in association with Enterobacter. Klebsiella pneumoniae was found at one site with a free residual chlorine of 0.45 mg/l and with no Enterobacter present. If the mechanism of resistance to free chlorine is production of slime layers, Enterobacter and Klebsiella may well be adapted to grow in distribution systems, and other coliforms could be incorporated in the slime layers that they produce. (Moore-IVI)
W84-01802

REMOVING URANIUM BY CURRENT MUNICIPAL WATER TREATMENT PROCESSES,
Oak Ridge National Lab., TN.
S. K. White, and E. A. Bondietti.
Journal of the American Water Works Association, Vol. 75, No. 7, p 374-380, July, 1983. 4 Tab, 25 Ref.

Descriptors: *Water treatment, *Uranium, Drinking water, Lime, Hydrogen ion concentration, Alum, Carbonates, Minerals.

Raw, intermediate-stage, and treated water samples from 20 public water supplies were analyzed for uranium content. The results indicate that current municipal water treatment practices are not effective in handling uranium. Raising the pH to 9.5 or greater (as in lime treatment) will result in uranium loss by precipitation, the amount of loss varying with the sample. Alum may be effective in uranium removal, but dosage will vary according to carbonate concentration and pH. Such experimentation suggests that uranium removal can be accomplished by water treatment processes with modification of pH, chemical dosages, or both; variation in the order in which treatments are carried out; and special attention to coeffects that exist because of the mineral content of the water or combinations of chemicals used in treatment. (Baker-IVI)
W84-01803

PROBLEMS OF SMALL WATER SUPPLIES,
For primary bibliographic entry see Field 4A.
W84-01820

ACTION OF CHLORINE DIOXIDE ON AQUATIC ORGANIC MATERIALS DURING THE DISINFECTION OF DRINKING WATER,
Hadassah Medical School, Jerusalem (Israel). Environmental Health Lab.
Ch. Rav-Acha, R. Blits, E. Choshen, A. Serri, and B. Limoni.
Journal of Environmental Science and Health, Vol. A18, No. 5, p 651-671, September, 1983. 6 Fig, 6 Tab, 33 Ref.

Descriptors: *Chlorination, *Drinking water, *Organic matter, Disinfection, Trihalomethanes, Chlorine dioxide.

Measurements were made of the total organic halogens produced in the National Water Carrier of Israel after disinfection with chlorine dioxide. Compared to chlorine, chlorine dioxide formed only a very small amount of chlororganic compounds. Mixtures of chlorine and chlorine dioxide which have been reported to reduce the concentrations of both the chlorinated organics as well as the chlorite ions produced by chlorine dioxide, were found not to be of significant benefit due to the fact that high bromide concentrations are present in the National Water Carrier. Thus high ratios of chlorine dioxide to chlorine are needed to reach a significant reduction in trihalomethane concentration. The amount of trihalomethanes can be satisfactorily reduced, however, when chlorine dioxide is introduced a few hours before chlorine. A comparison between chlorine and chlorine dioxide in regard to reaction with a series of polycyclic aromatic hydrocarbons showed that the chlorine dioxide reactions were more unique. While the highly carcinogenic compounds such as benz(a)pyrene and 1,2-benzanthracene react with chlorine dioxide much more rapidly than with chlorine, other hydrocarbons, such as naphthalene and fluoranthene react very little with chlorine dioxide but easily react with chlorine. Findings suggest that in contrast to chlorine which reacts by few possible pathways, chlorine dioxide reacts mainly as a one-electron acceptor. The main organic by-products of chlorine dioxide seem to be aldehydes, ketones and quinones, beside low molecular weight carboxylic acids. Although aldehydes and carboxylic acids are usually regarded as monitoxic materials, the toxicity of quinones and some keto-aldehydes are still largely unknown. (Baker-IVI)
W84-01858

POWER OF GRAVITY CUTS WATER COSTS,
Raymar Engineering, Inc., Walnut Creek, CA.
M. S. Fohrman.
Water Engineering and Management, Vol. 1. 130, No. 7, p 26-28, July, 1983. 4 Fig.

Descriptors: *Water resources development, *Gravity filters, *Water treatment facilities, Lake Hemet, California, Topography.

The Lake Hemet Municipal Water District in California has incorporated unique geographic features at its recently completed Theodore H. Eggen Filtration Plant. This was done by using a gravity flow system as part of the process train. As a result, total power requirements are less than 20 hp. The automated 5 million gallon per day plant required only one hour of supervision each day. Three raw water sources feed the treatment plant. In winter the water comes from the North Fork of the San Jacinto River and from Strawberry Creek. As winter flows diminish, water is diverted from the South Fork of the San Jacinto, which originates from Lake Hemet Dam. All three flows converge into an overflow diversion structure situated more than a mile upstream from the plant site. Filtration is accomplished by four filters in parallel arrangement. To take further advantage of the hilly terrain, a hydroelectric generation facility has been proposed. The system will then produce enough power to accomodate all the electrical needs of the plant with any surplus being sold to the electrical utility. (Baker-IVI)
W84-01912

CONTROL OPTIONS FOR NITRATES AND FLUORIDES,
Black and Veatch, Dallas, TX.
W. J. O'Brien.
Water Engineering and Management, Vol. 130, No. 7, p 36-38, 51, July, 1983. 4 Fig, 4 Tab, 7 Ref.

Descriptors: *Nitrates, *Fluorides, *Drinking water, Water quality, Standards, Public health.

Nitrate and fluoride concentrations in drinking water supplies must be controlled for sound public health reasons, primarily for the protection of two population groups - infants, and children up to the age of 14, respectively. Water containing concentrations of nitrate nitrogen greater than 10 mg/l has been known to produce a disorder known as methemoglobinemia in infants less than three months old. Fluoride controls are in force to prevent dental fluorosis, a discoloration or mottling that occurs when teeth are being formed. Strong base anion exchange resins have usually been the preferred method for removing nitrate from water supplies. The major problem is a fouling of the resin when ferrous iron is present in the raw water. Presently it is not economical to use anion exchange resins for removal of fluoride as resins exhibit no selectively for this element. Excess lime softening is frequently used and the amount of fluoride that can be removed by this method is proportional to the quantity of magnesium in the water. (Baker-IVI)
W84-01915

EFFECT OF THE 1981/82 WINTER ON WATER SUPPLIES,
P. S. Turton.
Weather, Vol. 38, No. 10, p 314-318, October, 1983. 1 Fig, 4 Tab, 5 Ref.

Descriptors: *Water supply, *Freezing, *Water distribution, Weather, Cold regions, Pipes, Water mains, Leakage.

After the severe winter of 1962/63 the water industry in England and Wales experienced little difficulty during wintertime for the next 15 years. However, 1978/79 and 1981/1982 reminded both the public and the water industry that water pipes are vulnerable to severe frost. Most of the water industry's resulting difficulties in these times were local inconveniences, a heavy burden on staff and an increase in operating costs. Generally the industry coped well in the 1981/82 winter although if the cold had been unbroken the strain would have been considerable. If the recent cold winters herald a longer period of frequent cold winters then the cumulative effect on water mains could be significant and hinder the authorities programs of enhanced leakage control. The mechanisms by which cold weather affects water mains is not well researched or understood as effort is being given toward discovering and repairing leaks. The public must learn to take adequate precautions to prevent burst pipes if they wish to help avoid temporary disruption of the supply of water in winter. (Baker-IVI)
W84-01991

REMOVAL OF BACTERIA FROM WATER BY ADHESION TO CROSS-LINKED POLY(VINYLPYRIDINIUM HALIDE),
Kyoto Inst. of Tech. (Japan). Dept. of Chemistry.
N. Kawabata, T. Hayaski, and T. Matsumoto.
Applied and Environmental Microbiology, Vol. 46, No. 1, p 203-210, July, 1983. 7 Fig, 4 Tab, 10 Ref.

Descriptors: *Disinfection, *Poly(vinylpyridinium halide), Organic carbon, Escherichia coli, Salmonella, Streptococcus, Staphylococcus, Pseudomonas, Adhesion, Bacteria, Water treatment.

Cross-linked poly(vinylpyridinium halide) was found to have a novel and remarkable ability to remove bacteria from water. For example, when 10 g (wet weight) of cross-linked poly(N-benzyl-4-vinylpyridinium bromide) was contacted with 20 ml of suspensions of Escherichia coli (97,000 to 9.7 x 10 to the 7th power /ml), Salmonella typhimurium (8.0 x 10 to the 6th power to 1.1 x 10 to the 7th power /ml), Streptococcus faecalis (5.0 x 10 to the 7th power /ml), Staphylococcus aureus (8.1 x 10 to the 7th power /ml), and Pseudomonas aeruginosa (320,000/ml) under stirring in sterilized physiological saline at 37 degrees C, 99% of the viable cells of these bacteria were removed in 2 to 6 h. When suspensions of these bacteria (100,000 to 10,000,000 cells per ml) were passed through a column (20 mm by 100 cm) of cross-linked poly(N-benzyl-4-vinylpyridinium bromide) at 37 degrees C with a flow rate of 0.8 to 1.4 bed volumes per h, 97 to 100% of the viable cells were eliminated from the suspensions during the treatment. Mechanistic studies demonstrated that cross-linked poly(vinylpyridinium halide) irreversibly captured these bacteria alive during the treatment. That is, total organic carbon was removed during the treatment, and the bacteria which adhered to the resin proliferated on the bacterial medium. The adhesion capacity was estimated to be 10 to the 10th cells per g (dry weight). Total organic carbon was also removed even when the bacteria were killed by heat treatment before the column studies. (Author's abstract)
W84-02052

INACTIVATION OF HEPATITIS A VIRUS AND INDICATOR ORGANISMS IN WATER BY FREE CHLORINE RESIDUALS,
National Inst. for Water Research, Pretoria (South Africa).
W. O. K. Grabow, V. Gauss-Muller, O. W. Prozesky, and F. Deinhardt.
Applied and Environmental Microbiology, Vol. 46, No. 3, p 619-624, September, 1983. 3 Fig, 1 Tab, 29 Ref.

Descriptors: *Hepatitis A virus, *Chlorination, *Disinfection, Drinking water, Water treatment, Viruses, Bacteriophage, Bacteria, Indicators, Virus inactivation.

Hepatitis A virus (HAV) and selected indicator organisms were mixed together in chlorine-demand-free buffers at pH 6, 8, or 10 and exposed to free chlorine residuals, and the survival kinetics of individual organisms were compared. HAV was enumerated by a most-probable-number dilution assay, using PLC/PRF/5 liver cells for propagation of the virus and radioimmunoassay for its detection. At all pH levels, HAV was more sensitive than Mycobacterium fortuitum, coliphage V1(representing a type of phage common in some sewage-polluted waters), and poliovirus type 2. Under certain conditions, HAV was more resistant than Escherichia coli, Streptococcus faecalis, coliphage MS2, and reovirus type 3. It was always more resistant than SA-11 rotavirus. Evidence is presented that conditions generally specified for the chlorine disinfection of drinking-water supplies will also successfully inactivate HAV and that HAV inactivation by free chlorine residuals can reliably be monitored by practical indicator systems consisting of appropriate combinations of suitable indicators such as coliform and acid-fast bacteria, coliphages, the standard plate count, and fecal streptococci. (Author's abstract)
W84-02059

METHODS AND RESULTS OBTAINED FROM THE TOXICOLOGICAL AND ECOLOGICAL TESTS OF WATER TREATMENT CHEMICALS (METHODEN UND ERGEBNISSE BEI DER TOXIKOLOGISCHEN UND OKOLOGISCHEN PRUFUNG VON WASSERBEHANDLUNGS-MITTELN),
Henkel KGaA, Duesseldorf (Germany, F.R.). Toxikologische und Okologische Lab.
W. Kastner, and P. Gode.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 2, p 39-47, 1983. 8 Tab, 32 Ref.

Descriptors: *Water treatment, *Chemical treatment, *Toxicity, *Environmental effects, Water treatment chemicals.

After a description of some of the important toxicological and ecological testing procedures, toxicological and ecological data, available in the literature, provided by the manufacturers or measured in our own laboratories are presented in a tabular fashion for some typical water treatment chemicals and their formulations. In addition, the chemical composition of those substances contained in several selected water treatment products are given, grouped according to their function and combinations as used. The areas of application, dosages, methods of application, as well as pH values and classification based upon regulations governing water treatment materials, are also given in tabular form. Based upon these data, the products and the individual components are toxicologically and ecologically assessed and an estimation as to the toxicological and ecological risks in their use is attempted. (Author's abstract)
W84-02061

INVESTIGATIONS ABOUT THE INFLUENCE OF SMALL NTA-CONCENTRATIONS ON THE FLOCCULATION PROCESS (UNTERSUCHUNGEN UBER DEN EINFLUSS KLEINER NTA-KONZENTRATIONEN AUF DEN FLOCKUNGSPROZESS),
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
H. Bernhardt, H. Schell, and M. Berger.
Zeitshrift fur Wasser und Abwasser Forschung, Vol. 16, No. 2, p 55-61, 1983. 11 Fig, 2 Tab, 11 Ref.

Descriptors: *Water treatment, *Flocculation, *Nitrilotriacetate, Iron, Filtration, Detergents, Water pollution effects.

Tests on flocculation disturbances by small concentrations of NTA (nitrilotriacetate) were made with the flocculation apparatus, developed by the Wahnbach Reservoir Association. For floc separation, a filter column filled with sand (particle size 0.8 - 0.9 mm) and a membrane filter (0.45 micro m) were used. A very soft water with the addition of 25 mg/l Sicron as turbid material was used. Flocculation followed with 1-6 mg/l Fe(3+) as iron-III chloride. A NTA content of > or = 0.5 mg/l H3-NTA (> or = 0.2 mg/l C) disturbs the flocculation process. With application of membrane filters, Fe concentrations of > or = 0.05 mg/l arise, when flocculation occurs with Fe-salts. The mechanism of flocculation disturbances is investigated and discussed on strength of the results of membrane filter filtrations with pore sizes 0.45 micro m and 0.20 micro m and ultra filtration with a separation limit of the molecular weight of nominally 10,000. The removal of turbid material is impaired to the same extent by NTA-contents in the water > or = 0.5 mg/l H3-NTA (> or = 0.2 mg/l C). The turbidity of such a water increases in spite of essential iron-III-salt quantities (addition of at least 5 mg/l Fe(3+)). Relatively small NTA-concentrations, such as could arise in water bodies as a consequence of a partial substitution for phosphates in detergents, can have a disturbing effect on the water treatment. (Moore-IVI)
W84-02063

SCANNING ELECTRON MICROSCOPY (SEM) EXAMINATION OF MANGANESE DEPOSITS ON FILTER MATERIALS USED IN DRINKING WATER PLANTS (RASTERELEKTRONEN-MIKROSKOPISCHE (REM) UNTERSUCHUNG VON MANGANABLAGERUNGEN AUF FILTERMATERIALIEN DER TRINKWASSERAUFBEREITUNG),
Bonn Univ. (Germany, F.R.). Hygiene Inst.
G.-J. Tuschewitzki, and W. Dott.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 15, No. 4, p 121-125, 1983. 12 fig, 22 Ref.

Descriptors: *Filters, *Manganese, *Water treatment, Biological treatment, Chemical treatment, Calcium, Silicon, Chloride, Aluminum, Iron.

Manganese deposits on different filter materials were investigated by SEM and microanalysis. Typical structures of the deposits were found on filter material of filters with biological processes: (1) nodule- and wart-shaped deposits arranged in layers; (2) tapering beadstring-like structures with a net-like surface running more or less parallel. On material of filters with chemical processes amorphous deposits without characteristic structures were found, e.g. in holes of pumice. The deposits were analyzed by microanalysis: manganese proved to be the predominating element. Considerable amounts of calcium were found, whereas silicon, chloride, aluminium and iron were determined to a lower extent. (Author's abstract)
W84-02070

5G. Water Quality Control

RESTORATION OF AQUIFERS,
J. Josephson.
Environmental Science and Technology, Vol. 17, No. 8, p 347A-350A, August, 1983. 2 Fig.

Descriptors: *Aquifer management, *Groundwater pollution, Groundwater management, Water resources development, Water treatment, Drinking water, Granular activated carbon.

Once an aquifer becomes contaminated there are three basic courses of action which may be taken: forbid use of the aquifer and obtain alternative supplies; attempt to rehabilitate it; or continue to use the aquifer but treat the water before use. The first step toward groundwater restoration is knowing the extent, thickness, rate of spread, and contents of a contamination plume. Conceivably, the zone of contamination could be both overlain and underlain by clean water. That is why the utmost care must be taken, when wells are screened, to account for the three-dimensional aspect of the plume when a monitoring well network is planned. The monitoring scheme used must consider plume spread in two horizontal and one vertical direction over time. A properly installed well monitoring system must monitor the entire thickness of the aquifer being studied. The cost of such wells could range from $400 to $3000 each. Costs for sample analysis could come to $200-$1500 per sample. Once a contaminated plume is identified and mapped, a treatment scheme is needed. Treatment alternatives are considered and then bench and pilot scale studies are conducted. Granular activated carbon (GAC) is a frequently adopted treatment for contamination episodes involving organic chemicals. In some cases multimedia filtration is carried out before GAC treatment as a precaution. In others, air stripping is used to reduce the amount of volatile organics. Aeration, catalyzed chemical oxidation and GAC adsorption have also been used to remove organic solvents including chloroform, carbon tetrachloride, and other low-molecular weight chlorinated hydrocarbons. Pressurized gas aeration followed by direct incineration is undergoing evaluation in place of air stripping. Microbes and an organics removal approach involving powdered activated carbon are being tested with activated sludge. Both reclamation of contaminated groundwater and aquifer recharge can present technical and legal problems. A major factor of the feasibility of groundwater reclamation is cost. (Baker-IVI)
W84-01775

MOVEMENT OF TYPHOID ORGANISMS IN SATURATED PERMEABLE SOIL,
Washington Univ., Seattle. School of Public Health and Community Medicine.
For primary bibliographic entry see Field 5B.
W84-01787

TETRACHLOROETHYLENE CONTAMINATION OF GROUNDWATER IN KALAMAZOO,
Kalamazoo City Dept. of Public Utilities, MI.
For primary bibliographic entry see Field 5F.
W84-01788

PROTECTING WATER SUPPLY AQUIFERS IN AREAS USING DEEP-WELL WASTEWATER DISPOSAL,
CH2M Hill Southeast, Inc., Gainesville, FL.
J. I. Garcia-Bengochea.
Journal of the American Water Works Association, Vol. 75, No. 6, p 288-291, June, 1983. 1 Fig, 2 Tab, 4 Ref.

Descriptors: *Deep-well injection, *Wastewater disposal, *Water pollution prevention, *Disposal wells, Groundwater pollution, Water quality control, Monitoring, Geohydrology, Florida.

The geohydrology of Florida allows deep-well injection of treated wastewater in some areas if care is taken to assure protection of overlying aquifers used for public water supplies. The state is underlain by a series of groundwater-bearing strata separated by thick and practically impervious layers. In the southern part of the peninsula, the deeper strata contain saltwater in highly transmissive zones that are effectively separated from the overlying freshwater strata. This allows for the high-rate injection of pretreated wastewater into the deeper saltwater zones. Precautions must be taken during construction, operation, and ultimate abandonment of the disposal wells to assure containment of injected wastes. When a disposal well is abandoned, complete sealing of the casing from the bottom to the surface is required. Monitoring water quality and potentiometric levels in adjoining aquifers is essential during construction, operation, and ultimate abandonment of the facility. (Moore-IVI)
W84-01790

SODA ASH TREATMENT OF A STRONTIUM-90-CONTAMINATED GROUNDWATER SEEP,
Oak Ridge National Lab., TN. Environmental Sciences Div.
B. P. Spalding, and I. L. Munro.
Journal of Environmental Quality, Vol. 12, No. 3, p 366-373, July-September, 1983. 3 Fig, 3 Tab, 17 Ref. DOE contract W-7405-ENG-26.

Descriptors: *Strontium-90, *Groundwater pollution, *Water pollution control, Radioactive waste disposal, Soda ash, Seep water, Chemical precipitation, Conductivity, Hardness, Oak Ridge National Laboratory.

A Sr-90 contaminated groundwater seep on the perimeter of a low-level radioactive solid waste disposal area at the Oak Ridge National Laboratory (ORNL) was treated by burying 315 kg of soda ash in the groundwater flow path leading to the seep, and placing 45 kg of soda ash on the surface of the seep. The concentration of Sr-90 in the seep water fell from an average of 7000 Bq/L to 900 Bq/L for the 90 d after burial, followed by a period of gradual rise back to pretreatment levels over the next 100 d. The electrical conductivity and pH of the seep water increased following soda ash burial, while water hardness fell. Hardness was highly correlated (r = 0.84) with Sr-90 concentrations over the entire 2-year observation period, indicating the similar behavior of Sr-90 and soluble Ca and Mg. This in situ softening of, and Sr-90 precipitation from, the seep water was achieved by coprecipitation of Sr-90 with Ca(Mg)CO3 until the buried soda ash was depleted by dissolution in the groundwater. The soda ash treatment of groundwater seeps appears to be most practical as an interim technique for those situations requiring an immediate, but temporary, corrective action. During this limited but effective period, more permanent corrective actions could be planned at the source of contamination. The electrical conductivity, pH, and hardness of the larger surface stream, into which this seep discharges, were not affected by the soda ash burial, most likely due to the approximately 2000-fold dilution effected by this stream. (Author's abstract)
W84-01810

HISTORY OF ENVIRONMENTAL WATER QUALITY MANAGEMENT IN SCOTLAND,
Clyde River Purification Board, East Kilbride (Scotland).
D. Hammerton.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 4, p 336-346, August, 1983. 22 Ref.

Descriptors: *Water quality, *Water management, Scotland, Legislation, Regulations, Surface water, Pollution control.

Historically the pollution of the aquatic environment has been as severe in Scotland as anywhere in the U.K. The development of an effective pollution control system has been painfully slow, as in England and Wales, and has resulted in a very different administrative framework. It is remarkable that two distinct methods of managing the water cycle should have been evolved within one small nation but there are sound geographical and political reasons for this and the Scottish system appears well suited to the needs of the country. Changes occurring during 1975 provided a major new impetus for local government and for the river purification boards. The previous 324 sewerage authorities had been replaced by 9 regional councils, which were also the strategic planning authorities, thus greatly simplifying and improving the consultative process. The regional council all have highly qualified headquarters staff and thus are able to provide a management service to ensure

that sewage works function at maximum efficiency. In order for the water authorities to meet the obligations of the Control of Pollution Act 1974, Part II, significant upgrading of their scientific expertise in all aspects of oceanography will be required. (Baker-IVI)
W84-01822

MODELING INLAND WATER QUALITY USING LANDSAT DATA,
Australian National Univ., Canberra. Dept. of Engineering Physics.
D. J. Carpenter, and S. M. Carpenter.
Remote Sensing of Environment, Vol. 13, No. 4, p 345-352, September, 1983. 1 Fig, 1 Tab, 11 Ref.

Descriptors: *Model testing, *Water quality, *Lakes, Turbidity, Algal growth, Remote sensing, Satellite technology, Landsat, Australia.

The water quality parameters turbidity and algal pigment concentration of freshwater lakes have been modeled and predicted using Landsat multispectral scanner data as multiple linear predictors. Satellite data for an area in South East Australia from seven occasions during 1978 and 1979 were used along with concurrent ground-based measurements from sampling sites on three lakes covering a wide range of water quality regimes. Date-independent models for turbidity and algal pigment were obtained using the satellite multispectral data and the water quality data from up to 21 sampling sites on one lake on six occasions. The sun elevation at the time of satellite overpass was included in the models to account for differences between dates, and the time of sample collection was included to compensate for diurnal variations in pigment fluorescence. These models were used to successfully predict these water quality parameters for this lake on a new occasion and for the two other lakes on three occasions. (Author's abstract)
W84-01853

BURIED PIPE SYSTEM FOR CONTROLLING EROSION AND SEDIMENT LOSS ON IRRIGATED LAND,
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
D. L. Carter, and R. D. Berg.
Soil Science Society of America Journal, Vol. 47, No. 4, p 749-752, July-August, 1983. 2 Fig, 2 Tab, 13 Ref.

Descriptors: *Erosion control, *Sediment control, *Furrow irrigation, Irrigation effects, Sediment erosion, Sedimentation basins, Tailwater, Agricultural runoff.

A new system comprised of a buried pipe, with riser inlets from the surface at intervals, along the lower end of furrow-irrigated fields was designed, installed, and evaluated on 21 fields to determine its effectiveness as an erosion and sediment loss control system for irrigated land. The system utilizes small sediment collection ponds with the riser inlets from the buried pipe serving as overflow outlets for the ponds. This system corrects convex-shaped field ends caused by erosion and solves an energy related erosion problem common on furrow-irrigated land. During the first season, these system removed from 80 to 95% of the sediment from runoff water and collected from 4.1 to 40.5 Mg/ha from 12 fields on irrigated land where detailed data were collected. All systems performed without problems and all convex end problems except one were corrected the first season. After the convex ends are corrected, the system continues to reduce sediment loss. This new system eliminates the tailwater ditch, puts more land into crop production, reduces weed problems, and prevents the usual problems associated with a wet tailwater ditch. The buried pipe erosion and sediment loss control system is a major advance in the control of erosion and sediment loss on irrigated land. (Author's abstract)
W84-01866

CONTAMINATION OF A MAJOR WATER SUPPLY BY GULLS (LARUS SP.); A STUDY OF THE PROBLEM AND REMEDIAL ACTION TAKEN,
Strathclyde Regional Council, Glasgow (Scotland). Water Dept.
For primary bibliographic entry see Field 5C.
W84-01897

COMPUTATION AND REPORTING OF DISSOLVED GAS LEVELS,
California Univ., Davis. Dept. of Civil Engineering.
J. E. Colt.
Water Research, Vol. 17, No. 8, p 841-849, August, 1983. 4 Tab, 33 Ref.

Descriptors: *Dissolved oxygen, *Water quality, *Dissolved gases, Seawater, Temperature effects, Salinity, Nitrogen, Argon, Water vapor.

Provisional standards are proposed for the computation and reporting of dissolved gas levels in freshwater and seawater. Total gas pressure should be reported in terms of excess pressure, while component gases such as nitrogen, argon, oxygen and water vapor should be reported in terms of partial or excess pressure. Barometric pressure, dissolved oxygen, water temperature and salinity must also be reported. Recent work in hyperbaric physiology has shown that the initial bubble formation depends on excess pressure and therefore excess pressure is the best predictor of the danger from supersaturation. The concentration of component gases should be expressed as partial pressure in mm Hg rather than percent saturation. Recommended formulae for the computation of gas saturation levels are presented. (Baker-IVI)
W84-01900

REGIONALIZATION OF WATER QUALITY IN THE UPPER FRASER RIVER BASIN, BRITISH COLUMBIA,
Inland Waters Directorate, Vancouver (British Columbia). Water Quality Branch.
P. H. Whitfield.
Water Research, Vol. 17, No. 9, p 1053-1066, September, 1983. 11 Fig, 4 Tab, 19 Ref.

Descriptors: *Water quality, *Cluster analysis, Fraser River, River basins, British Columbia, Water analysis.

Uniformity of water quality in the Upper Fraser River basin was examined using cluster analysis. Substantial variations in water quality were observed within the basin. The differences were largely related to the geology of the watersheds. Differences in water quality were more pronounced among the tributaries than along the mainstream of the Fraser River. The mainstream of the river could be considered to have three distinct reaches where water quality properties were relatively constant. Cluster analysis was a useful technique for establishing similarities and differences for both the tributaries and the mainstrem stations. Good agreement was obtained between the results of cluster analysis and examination of spatial concentration differences. The results of the two methods differed in cases where the rate of change in concentration appeared to be important. The cluster analysis technique used did not consider these changes. Inclusion of derived variables, reflecting the rate of change among sequential stations could improve the discrimination of this technique. The assignment of uniform water quality objectives or stream standards would not be practical due to the substantial differences in water quality observed between adjacent groups of stations. (Baker-IVI)
W84-01908

COST-EFFECTIVE REGULATORY OPTIONS FOR WATER QUALITY LIMITED STREAMS,
Wisconsin Univ.-Madison. Dept. of Economics.
M. H. David, and E. L. David.
Water Resources Bulletin, Vol. 19, No. 3, p 421-428, June, 1983. 2 Fig, 2 Tab, 7 Ref. Dept. of Commerce grant NA80OAA-D-0086.

Descriptors: *Permits, *Water pollution control, *Water quality standards, *Costs, Wisconsin, Regulation, Aeration, Transferable discharge permits, Rolling averages, Variable permits, Flow regulation.

With the pressure from industries and municipalities to reduce the waste water treatment costs associated with the permit limits needed to attain the goals of the Clean Water Act, attention has turned ways of introducing flexibility into the regulations without sacrificing the water quality goals. Wisconsin is the first state to have adopted a variety of options from which dischargers may choose when meeting their water quality requirements. These options were developed for the express purpose of minimizing the costs and maximizing the flexibility of the point source water quality regulations while ensuring that permitted discharge would not violate the water quality standards. Options that the state has made available to dischargers include: variable permits; rolling averages; transferable discharge permits; instream aeration; and flow regulation. Variable permits are probably the most cost-saving of the options because they reduce the average time period during which the most stringent limits must be met from 52 wk/yr to several weeks or months in the summer. Rolling averages adddress the inequity of limiting each discharger on the assumption that all others will be discharging at their maximum permitted level. Transferable permits are important because they allow equity considerations to be separated from efficiency. The option to increase the dissolved oxygen or flow of the river reduce somewhat the costs of abatement. Aeration has the additional advantage that it can be used in emergencies to maintain standards. A mixture of permit options is likely to be the most cost-effective and satisfactory strategy for meeting water quality standards. Variable permits, some form of cluster permits or rolling averages, transferable permits and instream aeration appear to be the most important options to use in meeting waste load allocations on the major rivers. (Moore-IVI)
W84-01927

SOIL EROSION AWARENESS AND USE OF CONSERVATION TILLAGE FOR WATER QUALITY CONTROL,
Iowa Agricultural and Home Economics Experiment Station, Ames.
P. F. Korsching, and P. J. Nowak.
Water Resources Bulletin, Vol. 19, No. 3, p 459-462, June, 1983. 4 Tab, 13 Ref.

Descriptors: *Soil erosion, *Farming, *Erosion control, *Attitudes, Behavior, Water pollution control, Conservation tillage, Iowa.

Water pollution through loss of topsoil from farmland continues to be a major problem, despite nearly 50 years of providing farmers technical and financial assistance for soil and water conservation. The technology for controlling erosion and water pollution is available, but farmers have been slow in implementing control practices. Using a random sample of 249 farmers from central Iowa, the relationship is examined between awareness of a soil erosion problem and the use of conservation tillage. Average farm size of the operators in the sample was 470 acres, and row crops, corn and soybeans, were the predominant crops. There was a high level of awareness of the need for erosion control, but a rather low level of awareness of the problems of soil erosion and water quality. Approximately 96% of the operators considered the Midwest and Iowa to have a medium or serious soil erosion problem, whereas only about 72% and 54%, respectively, saw a medium or serious problem in their own community or on their own farm. There is a strong relationship between the use of conservation tillage and perceived severity of erosion on the farm. Awareness of a soil erosion problem affects the use of conservation tillage, and awareness can be enhanced by experimental educational strategies such as the development and implementation of a soil and water conservation plan. (Moore-IVI)
W84-01931

TREND ASSESSMENT OF WATER QUALITY TIME SERIES,
University of Western Ontario, London. Dept. of Statistical and Actuarial Sciences.
A. I. McLeod, K. W. Hipel, and F. Comancho.

Water Resources Bulletin, Vol. 19, No. 3, p 537-547, August, 1983. 9 Fig, 1 Tab, 39 Ref.

Descriptors: *Water quality, *Statistical models, *Time series analysis, Acid rain, Logging, Environmental effects.

A general methodology is described for identifying and statistically modeling trends which may be contained in a water quality time series. A range of useful exploratory data analysis tools are suggested for discovering important patterns and statistical characteristics of the data such as trends caused by external interventions. To estimate the entries in an evenly spaced time series when data are available at irregular time intervals, a new procedure based upon seasonal adjustment is described. Intervention analysis is employed at the confirmatory data analysis stage to rigorously model changes in the mean levels of a series which are identified using exploratory data analysis techniques. Furthermore, intervention analysis can be utilized for estimating missing observations when they are not too numerous. The effects of cutting down a forest upon various water quality variables and also the consequences of acid rain upon the alkalinity in a stream provide illustrative applications which demonstrate the effectiveness of the methodology. (Author's abstract)
W84-01937

WATER QUALITY MANAGEMENT OF LAGUNA DE BAY,
World Health Organization, Manila (Philippines).
E. W. Lee, and B. L. Adan.
Journal of Environmental Engineering, Vol. 109, No. 4, p 886-899, August, 1983. 1 Tab, 4 Ref.

Descriptors: *Water quality management, *Planning, *Laguna de Bay, Philippines, Water resources development, Water pollution control, Eutrophic lakes, Saline water intrusion, Water supply, Urban areas, Water demand.

A comprehensive water quality management plan was prepared for the Lagunda de Bay Basin located near Metropolitan Manila, Philippines. The need for this management plan has been created by the confrontation between resources development and environmental conservation and made complex by the spill-over of Metro-Manila population, industrial and commercial growths and agricultural development in the watershed of this large inland tropical lake. Laguna de Bay is a large shallow lake which is currently hypereutrophic. It is also brackish part of the year as a result of tidal intrusions from Manila Bay up the Pasig River, which introduce not only marine water but also pollution for drainage in the downstream receiving waters. The water of this lake will be needed by the year 2000 to supply the expanding population of Metropolitan Manila, when present sources are fully developed and utilized. A water quality management plan was prepared by Government with the cooperation of international agencies to protect the natural resources so that the beneficial uses of the lake can be preserved. The initial phases of the comprehensive water quality management plan are under implementation. (Moore-IVI)
W84-01955

MODELING GROUND-WATER FLOW AT LOVE CANAL, NEW YORK,
GeoTrans, Inc., Reston, VA.
For primary bibliographic entry see Field 5B.
W84-01956

ACID DEPOSITIONS AND THE ENVIRONMENT,
York Univ. (England). Dept. of Biology.
M. J. Chadwick.
Ambio, Vol. 12, No. 2, p 80-82, 1983. 2 Fig, 50 Ref.

Descriptors: *Acid rain, *Environmental effects, Water pollution control, Nitrogen oxides, Sulfur dioxide, Oxides, Sulfur, Nitrogen.

Acidifying substances present in the atmosphere of major enviromental significance are oxides of sulfur and nitrogen. Atmospheric sulfur occurs in compounds in gas, liquid and solid phases. Residence times for atmospheric sulfur dioxide are estimated at 1 to 2 days. Wet deposition of sulfur compounds, mainly in aerosol form as sulfate, occurs by in-cloud and below-cloud scavenging. Control strategies for reducing acidifying substances emitted to the atmospheric will need to concentrate on one or more stages of fuel use: before burning, low N and S fuel; during burning, staged, catalytic or coal-limestone combustion; waste gas venting, flue gas desulfurization and ammonia injection. (Baker-IVI)
W84-01969

HYPOLIMNETIC AERATION OF A NATURALLY EUTROPHIC LAKE: PHYSICAL AND CHEMICAL EFFECTS,
British Columbia Ministry of the Environment, Vancouver. Fisheries Research and Technical Services Section.
K. I. Ashley.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 9, p 1343-1359, September, 1983. 16 Fig, 2 Tab, 52 Ref.

Descriptors: *Aeration, *Hypolimnion, *Eutrophic lakes, Water quality control, Thermal stratification, Turbidity, Nitrification, Oxygenation, Phosphorus, Carbon dioxide, Eutrophication, Fish winterkill, Nutrients.

A small naturally eutrophic lake was divided in half with a plastic curtain, and a hypolimnetic aerator was installed and operated in the experimental half for one year. Hypolimnetic aeration had no effect on thermal stratification during the ice-free season but circulated the entire experimental half under ice cover. Aeration increased hypolimnetic turbidity via reduced detrital sedimentation but did not affect epilimnetic transparency. Hypolimnetic oxygen concentrations were increased as was oxygen consumption as both sediment and water column oxidation of organic material was enhanced. Hypolimnetic ammonia concentrations were reduced and sufficient oxygen was added for nitrification to occur. Internal phosphorous loading and hypolimnetic orthophosphate concentrations were reduced but aerobic P regeneration increased. Aeration vented accumulated CO2 from the hypolimnion and decreased hypolimnion calcium, magnesium, bicarbonate, and orthophosphate content via calcium carbonate phosphate coprecipitation. Management applications of hypolimnetic aeration include reduction of internal nutrient loading for eutrophication control, improvement of water quality for domestic use, and prevention of fish winterkill. (Moore-IVI)
W84-01978

MEET ENVIRONMENTAL NEEDS FOR REFINERY EXPANSIONS,
Bechtel Great Britain Ltd., London (England).
M. W. Askew, S. A. Tapley, and R. A. Killick.
Hydrocarbon Processing, Vol. 62, No. 10, p 65-70, October, 1983. 2 Fig, 2 Tab, 1 Ref.

Descriptors: *Industrial wastes, *Environmental impact statement, Oil, Sulfides, Phenols, Heavy metals, Ammonia, Chlorine, Bioaccumulation.

Unique problems are associated with refinery expansions. Sources of wastes are often uncontrolled and their effects on the environment are seldom known. The environmental impact statement should include present environmental status, target environmental status, type and quantity of prospective emissions, impact of emissions, emission control, control technology, emission and environmental status monitoring, and economics and cost effectiveness. The expansion situation calls for additional items to be considered such as existing environmental impacts and status, source characteristics and quantification of existing emissions, possibilities for the integrated control and management of emissions, existing with new emissions within new pollution control systems, and the impact of environmental standards in determining the scope of an expansion project. In regarding aqueous emission problems, oil is the major concern along with sulfides and sulfur bearing organics, phenols, heavy metals, ammonia, free chlorine, salinity, solids in suspension, temperature, chronic and acute toxicity, and potential bioaccumulation of materials. (Baker-IVI)
W84-02015

BACTERIA AND ACIDIC DRAINAGE FROM COAL REFUSE: INHIBITION BY SODIUM LAURYL SULFATE AND SODIUM BENZOATE,
Ohio State Univ., Columbus. Dept. of Microbiology.
P. R. Dugan, and W. A. Apel.
Applied and Environmental Microbiology, Vol. 46, No. 1, p 279-282, July, 1983. 2 Fig, 15 Ref. OWRT grant B073-Ohio.

Descriptors: *Mine wastes, *Acid mine drainage, *Chemautotrophic bacteria, *Anionic detergents, Sodium lauryl sulfate, Sodium benzoate, Detergents, Water pollution control.

Coal mine drainage represents a major environmental problem in regions where high-sulfur coal is mined and mineral wastes are deposited. The problem results from exposure of pyritic minerals, found in intimate association with coal and other minerals, to the combined effects of atmospheric oxygen, moisture, and acidophilic Thiobacillus bacteria. The application of an aqueous solution of sodium lauryl sulfate and sodium benzoate (at approximately 60 parts of detergent per million parts of refuse by weight) to the surface of high-sulfur coal refuse resulted in the inhibition of iron- and sulfur-oxidizing chemoautotrophic bacteria and in the decrease of acidic drainage from the refuse, suggesting that acid drainage can be abated in the field by inhibiting iron- and sulfur-oxidizing bacteria. (Moore-IVI)
W84-02055

PREDICTING COLIFORM CONCENTRATIONS IN UPLAND IMPOUNDMENTS: DESIGN AND CALIBRATION OF A MULTIVARIATE MODEL,
Saint David's Univ. Coll., Lampeter (Wales).
D. Kay, and A. McDonald.
Applied and Environmental Microbiology, Vol. 46, No. 3, p 611-618, September, 1983. 4 Fig, 6 Tab, 40 Ref.

Descriptors: *Multivariate analysis, *Coliforms, *Reservoirs, *Watershed management, Regression analysis, Escherichia coli, Water quality, Mathematical models, Recreation, Water treatment, Bacteria, Catchment area, Water supply, Thruscross Reservoir, Fewston reservoir, England.

A multiple regression model was designed to predict concentration of Escherichia coli and total coliforms in two upland impoundments, Thruscross and Fewston reservoirs, which supply water to the city of Leeds (England). The multivariate approach has improved predictive capability over previous univariate linear models because it includes predictor variables for the timing and magnitude of hydrological input to the reservoirs and physiochemical parameters of water quality. A calibrated model for any particular site would give the catchment manager an information base by which to limit certain recreational activities during periods or at locations of peak bacterial loading. The multivariate approach would also allow the manager of a treatment plant of limited capacity to predict the period and severity of stress by a mixture of environmental conditions producing high bacterial loadings, and to investigate appropriate countermeasures. Regression analysis can provide a useful management tool in multiple-use catchment areas. (Moore-IVI)
W84-02058

REGULATION OF THE PH VALUE IN AQUACULTURE, TAKING THE NH4(+)/NH3(-) RATIO INTO ACCOUNT, (STEUERUNG DES PH-WERTES IN DER AQUAKULTUR UNTER BERUCKSICHTIGUNG DES NH4(+)/NH3(-)VERHALTNISSES),

Goettingen Univ. (Germany, F.R.). Inst. fuer Agrikulturchemie.
M. G. Eissa.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 5, p 153-156, 1983. 4 Fig, 26 Ref.

Descriptors: *Aquaculture, *Ammonia, *Hydrogen ion concentration, Carbon dioxide, Aeration, Nitrates, Nitrification, Calcium.

In aquaculture, feed remnants and excrement, as well as metabolic products from the fish, cause an intensive development of NH4(+), which is in equilibrium with the toxic NH3, depending on proton concentration and temperature. If the pH of productive water is raised, then there is an increase in the amount of NH3 released, so that the equilibrium shifts in favor of the ammonia. The object of this investigation was to follow the influence of the pH value of water throughout the mineralization process of the feed, by using CO2 gas and by applying montmorillonite covered with H(+) or with Ca(2+); also, to study the effects these measures had on the release of NH3 and on other water parameters. Five test variants were chosen. The lowest release of NH3 was recorded with the application of CO2 gas. The other parameters measured (pH, CSB, Ges-N, NH4(+) and NO3(-)) also produced lower values with this method. The highest concentration of NH3 was found in the varient using ventilation. The exchange of NH4(+)ions for H(+) and Ca(2+) ions had a diminishing effect on the release of NH3. The Ca(2+) montmorillonite clearly had a positive effect on the development of nitrate. This could be due to the adsorption of a pH range which was optimal for nitrification and thus favorable for Ca(2+) supply. (Author's abstract)
W84-02074

TRANSPORT OF PHOSPHORUS IN SURFACE RUNOFF AS INFLUENCED BY LIQUID AND SOLID FERTILIZER PHOSPHATE ADDITION,
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 5B.
W84-02121

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

OPTIMAL DESIGNS OF BRANCHED WATER SUPPLY NETWORKS,
Indian Inst. of Tech., Bombay. Dept. of Civil Engineering.
A. V. Chiplunkar, and P. Khanna.
Journal of Environmental Engineering, Vol. 109, No. 3, p 604-618, June, 1983. 4 Fig, 2 Tab, 21 Ref.

Descriptors: *Water supply development, *Decision making, Design criteria, Civil engineering, Water supply, Gravity flow, Mathematical studies.

A rational procedure for the optimization of branched water supply networks is developed in closed form, using the Lagrangian Multiplier Technique. The solutions are workable on calculators and obviate the requirement of computers in optimal design and successive reevaluations. Case studies on complete gravity and direct pumping systems are presented to illustrate the solution procedure. Specific examination is made of a simplified approach developed by Swamee to multibranch systems, considering each branch to be initially independent, thereby requiring one Lagrangian multiplier, while estimating the multiplication factor for that branch and later combining all branches by choosing the maximum multiplication factor for common sections. The design identified through this simplified approach has been compared with the exact design considering all the branches simultaneously, thereby requiring as many Lagrangian multipliers as the branches. Despite a marginal difference in the theoretical optimal diameters by the two approaches, the final design remains unchanged due to the requirement of discrete commercial pipe sizes. A complete algorithm for the estimation of theoretical optimal diameters along with a procedure for rounding off to the commercial sizes to minimize the difference in the design by the two approaches is also presented. (Baker-IVI)
W84-01770

RESOURCE ALLOCATION TO INTERRELATED PROJECTS,
Ben-Gurion Univ. of the Negev, Beersheba (Israel).
A. Mehrez, and Z. Sinuany-Stern.
Water Resources Research, Vol. 19, No. 4, p 876-880, August, 1983. 1 Fig, 4 Tab, 14 Ref.

Descriptors: *Decision making, *Model studies, Multiattribute utility function, Water resources development, Project planning.

A multiattribute utility function was used to specify the decision-maker's preferences, along with a zero-one budget model, to solve the problem of selecting among interrelated multiobjective long-range projects. Increasing the number of projects increases the complexity of the problem. The advantages of the model for relatively small problems are demonstrated by a case study dealing with a subset of Israeli water development projects for 1981. The concept of partitioning the utility function into attributes has proven useful for the decision maker, as it allows him to test the contribution of the sets of projects to each attribute separately. The possible negative impact of a project on an attribute is also considered. (Baker-IVI)
W84-01880

MODELING TELLS THE HYDRAULIC STORY,
Miller Engineering, Inc., King of Prussia, PA.
T. C. Miller, Jr.
Water Engineering and Management, Vol. 130, No. 9, p 34-35, August, 1983. 1 Fig.

Descriptors: *Model studies, *Hydraulic equipment, Water distribution, System analysis, Planning, Water management.

Hydraulic modeling can be an invaluable asset for optimizing existing or planned water distribution systems. In an aging water system, the need for hydraulic modeling is most commonly recognized when a major system improvement is being planned to a system that has become too complex to comprehend. In a new water system, the engineer has many improvement options available to him, and can use modeling to overview the scope, timing and cost effectiveness of each. Capital improvement planning is perhaps the most dramatic example of the benefits of hydraulic modeling. Basic steps to be considered prior to developing a hydraulic model include understanding how the system operates, identifying the scope of the questions that will be asked of the model, acquiring adequate source data, combining the acquired source data with the hydraulic modeling program, and identifying how the hydraulic model will be cost-effectively maintained and updated. Several case histories are briefly reviewed to discuss the practical application of hydraulic modeling to existing water systems and new water systems. (Baker-IVI)
W84-01916

PROBLEMS OF WATER RESOURCES PLANNING IN INDIA,
CH2M Hill Southeast, Inc., Gainesville, FL.
U. P. Singh.
Water Resources Bulletin, Vol. 19, No. 4, p 577-580, August, 1983. 5 Ref.

Descriptors: *Water resources development, *Planning, *India, Administration, Political aspects, Legal aspects, Public policy, International law, Feasibliity studies, Water rights, Social aspects.

Water resources planning in India since the First Five-Year Plan (1951-1956) has been a very important part of national development planning. However, records show that the results of such planning in the last three decades have fallen short of expectations because of various complex factors. Most of the limiting factors are administrative, political, legal, and philosophical, involving premature comprehensive planning, arbitrary selection of plan targets, administrative 'red-tape,' ineffective coordination among water resources related departments, and water ownership conflicts among various states and with neighboring countries. Other constraints are related to a lack of adequate dependable data, the inadequacy of project feasibility studies, and a lack of social and political discipline necessary for adequate mobilization of financial resources. (Author's abstract)
W84-01942

NATIONAL WATER ASSESSMENT: NEEDED OR NOT,
Utah Water Research Lab., Logan.
L. D. James, D. T. Larson, and D. H. Hoggan.
Water Resources Bulletin, Vol. 19, No. 4, p 595-603, August, 1983. 1 Tab, 9 Ref.

Descriptors: *National Water Assessment, *Water resources, *Water supply, Hydrologic budget, Drought, Floods, Water pollution, Economic aspects, Political aspects, Social aspects.

The Second National Water Assessment combined the accumulation of a great mass of information with interpretations to identify current and future water problems. The mass of information will provide an invaluable data base for many years. The contribution of the interpretations is less clearcut. Problems were identified from water budgets over areas about half the size of states rather than by focusing on the local and temporary situations (drought, flood, or pollution) that make water crises. Problems were highlighted without evaluating their economic, environmental, and social impacts. The need for solutions was implied without probing the costs or feasibility of possible remedies. Modifying the assessment process to overcome these problems will add to the work; but because the primary audience is composed of generalists, the change may be more in interpretation and presentation than in detail. The improved assessment may be costly, but it will save more than it costs through reduced planning costs and more efficient water management. The assessment should cover the range of water problems, compare standardized data, interpret hydrologic events in terms of economic consequences and other societal goals, project trends over a reasonable planning horizon, and communicate water information to the political process. (Moore-IVI)
W84-01945

DESIRED AND ACHIEVED OUTCOMES IN FEDERAL WATER RESOURCES PLANNING,
Battelle Human Affairs Research Centers, Seattle, WA.
P. A. Bolton, W. B. Lord, and J. A. Chase.
Water Resources Bulletin, Vol. 19, No. 4, p 655-661, August, 1983. 3 Fig, 2 Tab, 8 Ref. OWRT grant 14-34-0001-8404.

Descriptors: *Planning, *Water resources development, Social aspects, Evaluation, Decision making.

Local or project level planning occurs within most federal water resources programs. Such planning involves both federal and local participants, and commonly involves a range of interest groups. It is necessary to know what goals these participants believe the planning process ought to achieve in order to design planning procedures which will meet their expectations. Social judgment analysis was used to elicit those goals for respondents who had participated in one of five different federal water resources programs, in one of the five different roles. Respondents also evaluated the extent to which the planning activities in a recent project in which they had participated had actually attained the posited goals. The respondents believed that responsiveness to local problems was significantly more important than resolving conflicts or increasing public understanding. A fourth goal, achieving national objectives, was believed to be less impor-

tant than the other three. No significant differences in these goal evaluations were associated with the type of program in which the respondents had participated. However, there were significant differences associated with the respondent's role in the planning process. Respondents' ratings of the effectiveness of actual planning projects varied by both program and respondent role. (Author's abstract)
W84-01952

6B. Evaluation Process

EX POST FACTO ANALYSIS OF THE REGIONAL ECONOMIC IMPACT OF EXPENDITURES FOR RESERVOIR RECREATION,
Texas Agricultural Experiment Station, College Station. Dept. of Recreation and Parks.
For primary bibliographic entry see Field 6G.
W84-01829

MANAGING RIVER ENVIRONMENTS FOR THE PARTICIPATION MOTIVES OF STREAM FLOATERS,
Minnesota Univ., St. Paul. Coll. of Forestry.
C. D. McDonald, and W. E. Hammitt.
Journal of Environmental Management, Vol. 16, No. 4, p 369-377, June, 1983. 3 Fig, 1 Tab, 18 Ref.

Descriptors: *Recreation, *Motivation, Rivers, Social participation, Public participation, Floating, Rafting, Behavior.

Over 500 individuals engaged in raft or inner-tube floating on three streams were surveyed to ascertain their motives for engaging in this activity. Among the 28 reasons given, the most important ones centered around social experience. Factor analysis of their reasons for participation further identified five motives, ranked from most important: affiliation, experiencing nature, action/excitement, skill development and solitude. Based upon these findings it is suggested that river management might manipulate stream resources and on-site opportunities to correspond to floater participation motives in the following ways. One obvious way would be to provide opportunities for users to participate as groups. Crowding was not a concern of floaters and they felt no need to control the number of users on the streams, even though use was substantial. The fact that experiencing nature was an important motive on both urban and rural rivers implies that a remote environment providing solitude and a dispersed form of recreation is not essential for experiencing nature. The third major implication is the need for management to allow for an element of risk and excitement during the on-site experience, still maintaining safety guidelines. Stream characteristics that will provide opportunities for running rapids, taking acceptable risks, and developing skills should be identified. (Baker-IVI)
W84-01830

MULTICRITERIA ANALYSIS OF WATER ALLOCATION IN A RIVER BASIN: THE TCHEBYCHEFF APPROACH,
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W84-01879

ENHANCED ROLE OF WATER CONSERVATION IN THE COST-BENEFIT ANALYSIS OF WATER PROJECTS,
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
R. C. Griffin, and J. R. Stoll.
Water Resources Bulletin, Vol. 19, No. 3, p 447-457, June, 1983. 5 Tab, 20 Ref.

Descriptors: *Water conservation, *Cost-benefit analysis, *Planning, Water resources development, Water demand, Nonstructural alternatives, Economic evaluation, Water supply.

Revisions in the rules and procedures for performing cost-benefit analyses of federal water projects include a requirement that nonstructural and water conservation measures be incorporated into economic assessments of projects. Project analyses will now proceed as if water supplies were allocated most effectively, that is, to their highest valued uses. A related requirement provides that the net benefits of any project should now be valued using willingness to pay measures. Water conservation activities include: reducing the level or altering the time pattern of demand by metering, leak detection and repair, rate structure changes, regulation on use, education programs, and drought contingency planning; modifying management of existing water development and supplies by recycling, reuse, and pressure reduction; and increasing upstream watershed management and conjunctive use of ground and surface waters. A specific cost-benefit methodology was constructed to accomodate the revisions in rules and procedures. In addition to being consistent with federal mandates, this technique offers important advantages over the traditional requirements approach to water supply planning. The advantages of this approach are largely the result of utilizing water demand functions, together with water supply functions, in the evaluation procedure. Use of demand functions is recommended because these functions implicitly incorporate pricing as well as those technical opportunities for water conservation which are known to have positive net benefits. Use of demand functions also permits willingness to pay measures to be calculated for specific projects. (Moore-IVI)
W84-01930

ESTIMATION OF DIRECT IRRIGATION BENEFITS,
Colorado State Univ., Fort Collins. Dept. of Economics.
R. K. Sampath.
Water Resources Bulletin, Vol. 19, No. 3, p 469-476, June, 1983. 2 Fig, 1 Tab, 6 Ref.

Descriptors: *Irrigation, *Mathematical models, *Benefits, Water demand, Population dynamics, Estimating, Water supply.

For optimal allocation of resources, it is critical to arrive at proper estimations of direct benefits created by irrigation projects. The traditional and new methods of estimation of direct benefits from irrigation development were reviewed, highlighting the theoretical implications of these methods. Comprehensive formulas were derived to show the extent of bias in these methods. Since irrigation benefits occur over a long period of time, the dynamic aspects such as shifts in demand and supply functions for commodities due to changes in income, population, and technology cannot be overlooked. Ignoring these important dynamic aspects will lead to underestimation or overestimation of direct benefits. Shifts in demand that occur over time due to population growth are incorporated in a theoretical model for estimation of direct irrigation benefits. Formulas were derived for the estimation of total surplus and its distribution between consumers and producers. (Moore-IVI)
W84-01933

NATURE OF LONG RUN COST SAVINGS DUE TO WATER CONSERVATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
T. M. Walski.
Water Resources Bulletin, Vol. 19, No. 3, p 489-498, June, 1983. 8 Fig, 1 Tab, 10 Ref.

Descriptors: *Water conservation, *Foregone costs, Water resources development, Water supply facilities, Construction costs, Maintenance costs, Costs, Economic aspects, Capital.

Savings in capital, operation, and maintenance cost of new water supply facilities are referred to as 'long run foregone costs.' Any conservation measure leads to reduction of water use or loss; however, significant long run foregone costs are realized only when reductions in size or delays in construction of facilities result. In order to accurately evaluate these costs it is necessary to know which facilities are affected and how they are affected (eliminated, downsized, or delayed). The effects of several levels of conservation on long run foregone costs for an actual study are presented and some easy to use equations are derived that may be used to calculate such savings. Long run foregone costs resulting from water conservation are more dependent on the size and construction year of new water supply facilities than on the reduction in water use or loss. The foregone cost functions are not only frequently nonlinear, but they may be discontinuous. This is especially true when the decision to build or not to build a large facility at a fixed date must be made. If a facility affected by conservation is scheduled to be built within roughly five years of the beginning of the planning period, it is more economical to downsize the facility. If it is to be built later in the planning period, it is more economical to delay construction. (Moore-IVI)
W84-01936

EVALUATION OF OPERATIONAL CLOUD SEEDING PROJECTS,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 3B.
W84-01940

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

PRICE BEHAVIOR IN THE WATER MARKET OF NORTHEASTERN COLORADO,
Colorado State Univ., Fort Collins. Dept. of Economics.
R. L. Gardner, and T. A. Miller.
Water Resources Bulletin, Vol. 19, No. 4, p 557-562, August, 1983. 2 Fig, 2 Tab, 14 Ref.

Descriptors: *Prices, *Water market, *Colorado-Big Thompson water, Water shares, Irrigation water, Industrial water, Municipal water, Colorado.

Past prices of Colorado-Big Thompson water shares were analyzed using an asset pricing model which incorporated the growth rate in real returns to irrigation water and the value of potential urban water uses. A real growth rate in the returns to irrigation water was estimated at 5.3%. Nevertheless, market values for water shares have exceeded capitalized agricultural values since 1969. Historically, urban use potential was heavily discounted, but the implicit discount rate fell rapidly in the last decade. The expectation that water shares will eventually be sold to municipal or industrial consumers now appears to be reflected fully in water prices. The real value for an acre-foot share of Colorado-Big Thompson water is not expected to rise much above its 1980 real market value of $2,895. Prices in this range appear to fully reflect the willingness-to-pay for municipal and industrial water. Continuation of the present situation of high nominal interest rates and relatively low inflation rates will likely keep water prices below this level. (Moore-IVI)
W84-01939

DISTRIBUTIONAL ISSUES IN WESTERN MUNICIPAL AND INDUSTRIAL WATER SUPPLY,
Utah Univ., Salt Lake City. Dept. of Economics.
J. R. Miller, and D. A. Underwood.
Water Resources Bulletin, Vol. 19, No. 4, p 631-640, August, 1983. 1 Fig, 4 Tab, 12 Ref.

Descriptors: *Financing, *Repayment, *Municipal water, *Industrial water, *Irrigation water, Central Utah Project, Bonneville Unit, Utah, Cost allocation, Water allocation, Water policy.

Financing and repayment provisions of western water projects effect transfer of income among federal taxpayers, electric power users, local water users, and property owners. The Bonneville Unit of the Central Utah Project (CUP) is used as a case study in the distribution of municipal and industrial water costs. Bonneville Unit water is developed in two basins, 164,500 acre-ft or 53% in the Unita Basin and 148,500 acre-ft or 47% in the Bonneville Basin. Only 27,900 acre-ft of project water, less than 9%, remains in the Uinta Basin. The project is

at least nominally an irrigation project, as 66% of the water is committed for that purpose. The distribution of costs among taxpayers and water users in different political/geographical jurisdictions, and how this distribution is affected by water law, cost allocation procedures, and the choice of revenue source for local repayment of reimbursable costs were examined. Irrigation water is heavily subsidized, both in terms of the zero interest provision and the reliance on Basin Fund revenues for irrigation repayment. Some counties bear a portion of the cost of municipal and industrial water without receiving any of it. In counties which receive water, costs are shared between water users and property taxpayers. Except for the counties receiving no water, there is a close correspondance between the financial contribution and water received. The interest subsidy on municipal and industrial water repayment of implementation present water policy, the lack of open debate on water issues is unfortunate. (Moore-IVI)
W84-01950

PRICING IRRIGATION WATER IN DEVELOPING COUNTRIES,
North Carolina State Univ. at Raleigh. Dept. of Economics and Business.
J. A. Seagraves, and K. W. Easter.
Water Resources Bulletin, Vol. 19, No. 4, p 663-672, August, 1983. 1 Fig, 1 Tab, 21 Ref.

Descriptors: *Pricing, *Developing countries, *Irrigation, Marginal cost, Economic aspects, Water supply development.

Alternative combinations of water pricing and regulations are possible in allocating irrigation water. The best combination will depend on the value of water, ability to control deliveries, desire to subsidize agriculture, ownership traditions, crops grown, return flows, drainage problems, staff training, ability to collect fees, and the number of farmers. Marginal cost pricing is explained and identified with a way of thinking about administered prices rather than a rigid system. Alternative pricing schemes are illustrated and some conclusions are offered. Four different pricing systems can be distinguished: direct charges based on measured volumes; direct charges per share of the flow in a stream or canal; direct charges per acre irrigated; and indirect charges on crop outputs marketed or on other inputs purchased. Regulations and prices for irrigation water will reflect conflicting goals. Institutions which are appropriate for regulating and/or pricing irrigation water depend on a number of factors besides the goals. For economic efficiency reasons, it is desirable to base administered prices on the marginal cost of acquiring more water, or on its opportunity cost in alternative uses. However, it is often contended that prices based on marginal costs will be too high for farmers with low incomes. Marginal cost pricing of water has special relevance to seasonal shortages and chronic over-irrigation. Institutions for the management of water from irrigation canals are affected by the ease with which the flow can be measured. When flows are uncertain, shares rather than volumes of the water can be allocated to individual farms. It is not worthwhile to seek greater physical efficiency in all cases. The irrigation system that is economically most efficient depends on the value of water and other variables. (Baker-IVI)
W84-01953

6D. Water Demand

WATER FOR LAS VEGAS METROPOLITAN AREA,
URS Co., Las Vegas, NV.
D. A. Haselhoff.
Journal of Environmental Engineering, Vol. 109, No. 3, p 700-712, June, 1983. 2 Fig, 7 Tab.

Descriptors: *Water demand, *Las Vegas, *Nevada, *Water supply development, Water conservation, Population growth, Groundwater, Water reuse, Arid areas, Urban areas, Water management, Economic aspects.

The Las Vegas area is one of the most arid parts of the driest state in the nation. It is among the fastest growing areas in the nation, and water supplies must be sought and managed to meet the demands of this growth. Water suppplies currently available include groundwater, Colorado River water, and wastewater reuse. New sources of water supply include groundwater stored in adjacent valleys and potentially vast quantities of water stored in deep-carbonate aquifers. Water demand functions were developed by different user classes including residential, commercial, industrial, civic, agricultural and non-agricultural irrigation, and system losses. These functions can assist other planners in determining water use in arid climates. The Las Vegas metropolitan area can manage water resources to meet needs for at least the next 50 years. Unique characteristics of the valley required assessment of all components of the water resource system so that water would be economically available for growth. Projected supply exceeds projected demand through at least the year 2020 considering various factors that can reduce available supply. Projected demand can be reduced by successful water conservation programs. An implementation program was developed to provide economical water by protecting existing supply, managing that supply wisely to meet peak demands, and exploring for new water supply sources when present sources are no longer adequate to meet demands of growth. (Moore-IVI)
W84-01774

MULTICRITERIA ANALYSIS OF WATER ALLOCATION IN A RIVER BASIN: THE TCHEBYCHEFF APPROACH,
Princeton Univ., NJ. Dept. of Civil Engineering.
N. P. Greis, E. F. Wood, and R. E. Steuer.
Water Resources Research, Vol. 19, No. 4, p 865-875, August, 1983. 7 Fig, 5 Tab, 23 Ref.

Descriptors: *Water allocation, *Multicriteria analysis, Computer models, Delaware River Basin, Seasonal water allocation, Linear optimization, Water demand, Comsumptive use.

A new interactive multiple objective methodology is applied to the seasonal water allocation problem. Linear optimization and filtering procedures are combined within a multiobjective framework in order to identify nondominated solutions associated with randomly sampled criteria vectors. The procedure samples from the entire nondominated set, not just the set of nondominated extreme points, by computing the nondominated criteria vector that is closest to an ideal criteria vector according to a weighted Tchebycheff metric. Unlike many other multicriteria methods, the Tchebycheff procedure is capable of finding solutions of highest utility which may not correspond to extreme point solutions. The procedure is applied to the problem of water allocation in the Delaware River Basin where a large number of conflicting objectives, including environmental objectives, compete for the available supply. The basin has large consumptive needs, and demand for water is gradually outstripping supply, causing frequent, often severe shortages in several sectors. (Moore-IVI)
W84-01879

ALTERNATIVE STRUCTURES FOR WATER RIGHTS MARKETS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. W. Eheart, and R. M. Lyon.
Water Resources Research, Vol. 19, No. 4, p 887-894, August, 1983. 2 Fig, 2 Tab, 17 Ref.

Descriptors: *Water rights, *Water comsumption, *Permits, Water rights markets, Riparian rights, Economic aspects.

The most important considerations for the the design of systems of marketable permits for water consumption from natural watercourses are those associated with (1) uncertainty of future streamflows and economic conditions, (2) locational issues, and (3) efficient and effective functioning of the markets. In regions presently following the riparian doctrine the most important design decisions include the basis of definition of permits, the means for initially distributing them, the type of market mechanism used for their transfer after they are issued, and the restrictions placed on their use and transfer. It is uncertain whether or not the PSUR (Prioritized Steady Use Rights) definition basis will be more or less economically efficient than the FFR (Fractional Flow Rights) basis. The PSUR approach has a long-standing precedent in the appropriative rights system of the western U.S., but the FFR system is operationally simpler, more easily adaptable to formal market procedures, and more amendable to free initial distribution schemes in riparian regions. In choosing a definition basis, the size of zones, and whether to use a lentic or lotic system, trade-offs may develop among economic efficiency, operational simplicity, and the nonmanipulated functioning of the market. (Moore-IVI)
W84-01882

TEN YEARS TO SLAKE A GLOBAL THIRST,
A. Charnock.
New Scientist, Vol. 97, No. 1348, p 661-665, 10 March, 1983. 5 Fig.

Descriptors: *Water resources development, *Social change, Human diseases, Schistosomiasis, Onchocerciasis, Malaria, Latrines, Developing countries, Water supply, Groundwater, Public health.

Four-fifths of the diseases in the Third World nations are linked to dirty water and lack of sanitation. Among these diseases are onchocerciasis, schistosomiasis, and malaria. Three out of five people in these nations have no easy access to clean water. Attempts to remedy the situation have focused mainly on groundwater sources. One of the major problems is repair of mechanical equipment. In most cases the people using the equipment are unable to fix it, should something break down. If the machinery is highly sophisticated, then the government of that nation must spend limited funds on replacement parts abroad, as their manufacturing techniques are not on a par with what is needed to replace the damaged equipment. Low cost systems are seen as better for these areas with the handpumps taking priority over the more expensive piped water supply schemes. Much is being done with plastics now in place of metal parts as plastics are cheaper, light and easy to replace. Various latrine designs in regular use in the Third World nations are briefly described. (Baker-IVI)
W84-02011

6E. Water Law and Institutions

ACID RAIN: A RAPIDLY SHIFTING SCENE,
For primary bibliographic entry see Field 5B.
W84-01777

FROM DREAM TO REALITY: LAKE MICHIGAN WATER FOR FOUR CHICAGO SUBURBS,
PRC Consoer Townsend, Inc., Chicago, IL.
For primary bibliographic entry see Field 5F.
W84-01786

GROUNDWATER LAWS: OPPORTUNITIES FOR MANAGEMENT AND PROTECTION,
Calhoun, Hubbard, Riddle and Cox, Savannah, GA.
For primary bibliographic entry see Field 4B.
W84-01789

COST-EFFECTIVE REGULATORY OPTIONS FOR WATER QUALITY LIMITED STREAMS,
Wisconsin Univ.-Madison. Dept. of Economics.
For primary bibliographic entry see Field 5G.
W84-01927

VIEWS OF WESTERN WHITEWATER FLOATERS TOWARD POSSIBLE SAFETY MEASURES,

North Central Forest Experiment Station, St. Paul, MN.
J. H. Schomaker.
Water Resources Bulletin, Vol. 19, No. 3, p 463-467, June, 1983. 1 Fig, 1 Tab, 9 Ref.

Descriptors: *Boating, *Recreation, *Safety, *Attitudes, Whitewater boating, Management, Regulations, Rivers.

For a risk recreation activity like whitewater boating, a manager's goal of providing for the health and safety of the visitor may conflict with the goal of providing the opportunity for a satisfying recreation experience. As whitewater river managers face the problem of safety and risks, they should consider what users think about safety programs. The views of whitewater boaters toward (1) first aid equipment requirements, (2) signs warning of hazards, (3) aggressive enforcement of the rules, and (4) patrols to assist and regulate users were determined on 13 river segments in the western United States. A test was made of the relation between viewers toward safety measures and the level of risk and thrills sought by floaters. Conclusions of the study are: (1) river floaters' views toward possible management safety measures are not related to the amount of risk they desire; and (2) floaters, in general, prefer some safety measures to others. If safety measures mean that managers will be more visible on the river, floaters tend to dislike them. Therefore, a manager's approach to safety management should parallel the approach to recreation management in general, and regulation of use should be the minimum necessary to achieve safety objectives. (Author's abstract)
W84-01932

UPSTREAM-DOWNSTREAM: RIGHTS AND RESPONSIBILITIES,
Technical Univ. of Nova Scotia, Halifax. Dept. of Civil Engineering.
D. H. Waller.
Canadian Journal of Civil Engineering, Vol. 10, No. 3, p 362-368, 1983. 2 Fig, 2 Tab, 3 Ref.

Descriptors: *Storm runoff, *Legal aspects, *Canada, Riparian rights, Drainage effects, Storm water, Natural watercourses, Land development, Public policy, Flood damage, Downstream.

A lengthy trial in the Supreme Court of Nova Scotia may influence design of future stormwater systems in Canada. The developer of a 203 ha area sued an upstream developer and the provincial department of transportation, claiming real and anticipated damages from increased flows and volumes of stormwater. The plaintiff claimed that it was entitled to have the defendants reduce quantities and rates of flow, or to have costs of enlarging its system paid by the defendants. The Court concluded that the defendants were not required to restrict flows to pre-development levels as long as they used natural watercourses and did not cause their natural capacity to be exceeded. The downstream owner is obligated to accept the increased flows, to design watercourse modifications to accomodate these flows, and to base his determination of flows on a 100 year rainfall event. An indirect result of the court case, and of the situation that produced it, was the creation of the Halifax County Storm Drainage Task Force. Most of the problems that led to the court case would have been avoided if the policies and criteria had been in place to guide the activities is both upstream and downstream developers. If cost-effective implementation of stormwater policies and criteria is to be achieved, preparation of drainage master plans and development of cost-sharing mechanisms are essential. (Moore-IVI)
W84-01982

EFFECT OF THE 1981/82 WINTER ON WATER SUPPLIES,
For primary bibliographic entry see Field 5F.
W84-01991

PRIORITY POLLUTION RIGHTS: ADAPTING POLLUTION CONTROL TO A VARIABLE ENVIRONMENT,
Colorado Univ., Boulder. Dept. of Economics.
C. W. Howe, and D. R. Lee.
Land Economics, Vol. 59, No. 2, p 141- 149, May, 1983. 1 Fig, 13 Ref.

Descriptors: *Water pollution control, *Legal aspects, Appropriation, Environment, Waste disposal.

Variability in the assimilative capabilities of the environment and in demands for the waste disposal services of the environment pose difficult problems for pollution control systems. A feature is proposed for pollution rights systems that is expressly designed to deal with environmental variability in an economically efficient manner. The system is referred to as a priority pollution rights system (P.P.R.S.). It is an adaptation of the long standing system of appropriations doctrine found in western U.S. water law. The P.P.R.S. has much greater flexibility and makes more efficient use of privately held technological and cost information than alternative instruments of control in adapting pollutant discharge rates to variations in the assimilative capabilities of the environment. Possibilities of undesirable forms of strategic behavior in the market warrent further study, but such possibilities exist under all instruments. Successful experience with priority water rights in the western U.S. bodes well for similar systems in the field of pollution control. (Baker-IVI)
W84-02049

6F. Nonstructural Alternatives

ENHANCED ROLE OF WATER CONSERVATION IN THE COST-BENEFIT ANALYSIS OF WATER PROJECTS,
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W84-01930

6G. Ecologic Impact Of Water Development

EX POST FACTO ANALYSIS OF THE REGIONAL ECONOMIC IMPACT OF EXPENDITURES FOR RESERVOIR RECREATION,
Texas Agricultural Experiment Station, College Station. Dept. of Recreation and Parks.
J. H. Gramann.
Journal of Environmental Management, Vol. 16, No. 4, p 357-367, June, 1983. 5 Tab, 14 Ref.

Descriptors: *Reservoirs, *Recreation, *Economic impact, Economic justification, Water resources development, Management, Prediction, Illinois.

A comparison is made between the predicted and actual economic impact of recreation expenditures at a reservoir in the state of Illinois. Although originally designed for multiple uses, the reservoir is justified primarily in terms of recreation. Expenditure data collected from a representative sample of reservoir visitors are utilized in an input-output analysis to determine the direct, indirect, and induced effects of these expenditures on personal income in the two counties in which the reservoir is located. Recreation expenditures directly and indirectly accounted for 1.3% of total personal income in the two-county region, which contrasts sharply with the optimistic forecasts of civic boosters and project planners. Several criticisms of pre-reservoir economic impact assessments are made. Among these are their focus on total recreation expenditures rather than on income derived from expenditures, and the failure of project supporters to distinguish spending by local from non-local visitors. Both practices inflated considerably the predicted impact of recreation expenditures. Input-output matrices for the area show the retail sector of the economy to be relatively independent of other economic sectors. Although the impact of recreation expenditures is felt mostly in retail enterprises, the low level of retail development, together with that sector's structural independence, indicates that overall economic impacts will continue to be small. (Author's abstract)
W84-01829

SEDIMENTATION, ACCRETION, AND SUBSIDENCE IN MARSHES OF BARATARIA BASIN, LOUISIANA,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2L.
W84-01835

EFFECTS OF REGULATION OF THE RIVER TEES UPON FISH POPULATIONS BELOW COW GREEN RESERVOIR,
For primary bibliographic entry see Field 2H.
W84-01837

FISH OF CHANNELIZED AND UNCHANNELIZED SECTIONS OF THE BUNYIP RIVER, VICTORIA,
James Cook Univ. of North Queensland, Townsville (Australia). School of Biological Sciences.
For primary bibliographic entry see Field 2H.
W84-01839

EFFECTS OF IMPOUNDMENTS ON DOWNSTREAM BED MATERIALS OF TWO UPLAND RIVERS IN MID-WALES AND SOME ECOLOGICAL IMPLICATIONS OF SUCH EFFECTS,
Ministry of Agriculture and Water Development, Lusaka (Zambia).
J. Scullion.
Archiv fur Hydrobiologie, Vol. 96, No. 3, p 329-344, March, 1983. 3 Fig, 4 Tab, 39 Ref.

Descriptors: *Rivers, *Environmental effects, *Impoundments, Flow rates, Macroinvertebrates, Physical properties, Substrates, Wales.

Physical properties of substrate such as particle size composition, gravel porosity, organic matter content, permeabilities, and apparent water velocities of two regulated and two unregulated rivers were studied over a period of about one year. During this period these properties did not change appreciably, despite substantial flow fluctuations of unregulated rivers. There were few significant differences between regulated and unregulated rivers despite the elimination or reduction of summer and autumn spates by regulation. The most ecologically important effects of regulation on the macroinvertebrate fauna would seem to be the occlusion of bed surfaces by deposits, rich in iron and manganese derived from storage reservoirs, and changes in the temperature regime. The effects of regulation on salmonid egg survival are also discussed. (Baker-IVI)
W84-01843

ATTEMPTED RECONSTRUCTION OF THE FAUNA OF LARGE RIVERS AND FLOOD PLAINS OF EUROPE (VERSUCH EINER REKONSTRUKTION DER FAUNA EUROPAISCHER STROME UND IHRER AUEN),
E. J. Fittkau, and F. Reiss.
Archiv fur Hydrobiologie, Vol. 97, No. 1, p 1-6, May, 1983. 6 Ref.

Descriptors: *Rivers, *Fauna, *Flood plains, Aquatic life, Nutrients, Flooding, Europe.

The fauna of the large European rivers has been destroyed before it was possible to carry out a full investigation. The destruction of this fauna has been brought about not only through canalization of the rivers for ship traffic but also through the introduction of industrial effluents and the cultivation of the flood plains. The flood plains, with their numerous small and large lotic and lenitic waters, together with the river constitute an ecological entity. The habitats 'Fluss-Aue' are continuously formed and preserved through flooding and have been the place producing the basic nutrient component for the zoocoenoses of the river and the hatching area for migrating fishes. The waters of the flood plains, by their enormous continuity, in time, become of great significance for the evolution of the aquatic fauna. (Author's abstract)
W84-01846

ANALYSIS OF DISSOLVED OXYGEN CONCENTRATIONS IN TAIL WATERS OF HYDROELECTRIC DAMS AND THE IMPLICATIONS FOR SMALL-SCALE HYDROPOWER DEVELOPMENT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. F. Cada, K. D. Kumar, J. A. Solomon, and S. G. Hildebrand.
Water Resources Research, Vol. 19, No. 4, p 1043-1048, August, 1983. 3 Fig, 2 Tab, 14 Ref. DOE contract W-7405-eng-26.

Descriptors: *Hydroelectric power, *Dissolved oxygen, *Tailwater, Dam effects, Environmental effects, Water quality, Seasonal variation, Small-scale hydropower.

Dissolved oxygen concentrations in reservoir tail waters from operating hydroelectric sites were paired with dissolved oxygen measurements from nearby downstream Geological Survey water quality stations. A total of 65 small-scale hydroelectric sites were selected, of which four did not have both winter and summer dissolved oxygen data; 74 large-scale hydroelectric sites were paired with nearby water quality stations, three of which did not have both winter and summer data. These data were used to calculate probabilities of noncompliance (PNC's), that is, the probabilities that dissolved oxygen concentrations in the discharge waters of operating hydroelectric dams will drop below 5 mg/l. The continental states were grouped into eight regions based on geographic and climatic similarities. Most regions had higher mean PNC's in summer than in winter, and summer PNC's were greater for large-scale than for small-scale hydropower facilities. PNC's were generally less than 0.05 during the winter months, regardless of generating capacity. Cumulative probability distributions of PNC also indicated that low dissolved oxygen concentrations in the tail waters of operating hydroelectric dams are phenomena largely confined to sites with large-scale facilities. PNC's are not a function of electrical capacity per se but rather appear to be dependent upon factors related to capacity, such as reservoir depth. Potential dissolved oxygen problems are unlikely to hinder small-scale hydropower development in the U.S. (Moore-IVI)
W84-01896

RECREATION AT DRINKING WATER RESERVOIRS IN MASSACHUSETTS: A SURVEY OF WATER MANAGERS,
Massachusetts Univ., Amherst.
L. R. Klar, Jr., and A. Ghirin.
Water Resources Bulletin, Vol. 19, No. 3, p 477-481, June, 1983. 5 Tab, 12 Ref. OWRT WRA 107-MASS.

Descriptors: *Reservoirs, *Recreation, *Massachusetts, *Water pollution sources, Drinking water, Fishing, Water management, Municipal water, Attitudes, Regulations, Watersheds.

The recreational use of public drinking water reservoirs in Massachusetts is quite limited, particularly in comparison to other parts of the country. A survey was conducted of 51 municipal water supply managers in Massachusetts. Water officials were found to advocate highly restrictive views. Of the agencies owning or controlling their own reservoirs, 62.5% had policies prohibiting all recreational activities on their reservoirs or surrounding watershed areas. Fishing was the most common activity allowed among agencies permitting recreation. Managers from agencies owning or controlling no reservoirs were more likely to favor recreation to a significant degree. No officials said that recreation was an insignificant source of water supply pollution, and opinions were not found to be related to respondents' exposure to the literature on the topic. The majority of managers were not familiar with the literature assessing the impact of recreation on water supply reservoirs. (Moore-IVI)
W84-01934

NEW COURSE FOR THE NILE,
A. Charnock.
New Scientist, Vol. 100, No. 1381, p 285-288, 27 October, 1983. 9 Fig.

Descriptors: *Water resources development, *Enviromental effects, *Social change, Canals, Nile River, Sudan, Jonglei Canal.

A 50 year old plan to divert the Nile away from the swamps of south Sudan is nearing completion. The Jonglei Canal should improve communications and agriculture, but the effects on the local populations are not clear. The Canal will divert a quarter of the White Nile's waters in a 360 km channel that will bypass the Sudd swamps, 600 km south of Khartoum where more than half of the Nile's flow evaporates every year. The canal should shrink the swamps and their floodplains, and present the first man-made barrier to a cycle of pastoral migration which has existed for thousands of years. Opportunities to expand health services will be improved. The major concern is the possible spread of the schistosome parasite. (Baker-IVI)
W84-02010

CHANGES IN THE SEDIMENTARY FLUXES IN LAKE WALCHENSEE BY ANTHROPOGENICALLY CAUSED ALTERATIONS OF ITS CATCHMENT AREA (VERANDERUNGEN IM SEDIMENTATIONSGESCHEHEN DES WALCHENSEES DURCH ANTHROPOGENE EINGRIFFE IN DAS EINZUGSGEBIET),
C. Steinberg, E. Hammerle, and J. Meilhammer.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 16, No. 2, p 48-54, 1983. 11 Fig, 14 Ref.

Descriptors: *Environmental effects, *Sediment transport, *Diversion, Catchment areas, Lake Walchensee, Upper Isar River, Rissbach Brook, West Germany, Calcium, Phosphorus, Chlorophyll, Plant pigments, Wastewater, Agricultural runoff, Water resources development, Land development.

Diversion of the Upper Isar River (since 1924) and the brook Rissbach (since 1950) into Lake Walchensee (Upper Bavaria, Germany, F.R.) for energy purposes enlarged the lake's catchment area from 59.3 sq km to 783.6 sq km. The catchment area of the Upper Isar River contributes 510 sq km. Since the diversions drain into different bights of the lake, their effects on biogeochemical cycling in the lake can be studied by determination of the sedimentary fluxes in the corresponding bight. The annual sedimentary fluxes of calcium, phosphorus and plant pigments (chlorophyll a and degradation products) for the two bights receiving the diversions are compared with the flux in a third bight not influenced by a diversion. The diversion of the Upper Isar River increased the sedimentary flux of calcium from 30 to 900 g/sq m/a Ca. This value is more or less constant since the mid fifties. The phosphorus flux increased from 100 to 1,000-1,500 mg/sq m/a P and reached maximum values of 2,500 to 7,400 mg/sq m/a since the end fifties. These increases are due to the development of various tourist facilities, e.g. mountain-railways etc., as well as increase in wastewater quantities, and agricultural intensification in the catchment area. The sedimentatary flux of plant pigment reflects this situation. Prior to 1924, less than 6.0 mg/sq m/a pigment were sedimented, between 1924 and 1957, 30 to 80 and thereafter up to 330 mg/sq m/a. The diversion of the brook Rissbach into the lake led to a sedimentary flux of calcium of 1 to 3 kg/sq m/a with decreasing rates in the past five years. This is also true for the phosphorus sedimentary flux since about 1971: in the most recent layers the data oscillate around 2,000 mg/sq m/a P. This value is only about one third of the flux influenced by the River Isar. There is a steady increase in the deposition of plant pigments since 1960. (Moore-IVI)
W84-02062

7. RESOURCES DATA

7B. Data Acquisition

WATER CENTRE DEVELOPS GROUND RADAR,
J. Bell.
New Scientist, Vol. 98, No. 1363, p 870-871, 23 June, 1983. 2 Fig.

Descriptors: *Ground radar, *Sewer systems, Leakage, Pipelines, Collapse, Mapping.

Five thousand of the big holes that appear in Britain's roads every year may be blamed on collapsed or blocked sewers. Ground radar, to spot the voids that sewers fall into, is now in the experimental prototype stage. The theory is that if radar could detect voids outside the sewers (often caused by burst sewers leaking and washing soil away) then it should be possible to prevent some of the expensive collapses. The prototype, which consists of two antennas in a perspex tube, is a variable frequency machine. It has to be variable because radar penetration underground may change randomly according to the presence or absence of gaps, stones, water, sand, and so on. Damage to sewers may also be prevented by electronic mapping, thus avoiding the loss of sewer and water mains over the years through the lack of accurate records as to their original placement. (Baker-IVI)
W84-02013

8. ENGINEERING WORKS

8A. Structures

OPTIMUM DESIGN OF SMALL RESERVOIRS (TANKS),
California Univ., Davis. Dept. of Civil Engineering.
O. J. Helweg, and P. N. Sharma.
Water Resources Research, Vol. 19, No. 4, p 881-885, August, 1983. 2 Fig, 2 Tab, 9 Ref.

Descriptors: *Design criteria, *Reservoirs, Tanks, India, Arid regions, Construction, Model studies.

Small reservoirs, called tanks, are part of traditional water transport methods in the semiarid tropics of India and other countries. While considerable investment is being planned to construct more of these tanks, no investigation has been made to determine the most efficient design for them. Assuming the most efficient operating policy and tank location, there are two separable optimization problems in designing a small tank or reservoir irrigation system. The first deals with optimal tank dimensions and the second with optimal storage capacity. The size of a tank irrigation system may either be constrained by the catchment area available for producing runoff and/or the limited area suitable for irrigation. An example of a small reservoir irrigation system for Hyderabad region in south India is presented as a demonstration of the method of design. (Baker-IVI)
W84-01881

EROSION IN RELATION TO FILTER DESIGN CRITERIA IN EARTH DAMS,
California Univ., Davis.
For primary bibliographic entry see Field 8D.
W84-01958

8B. Hydraulics

MOUND FORMATION AT CULVERT OUTLETS,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. R. Abt, J. F. Ruff, and C. Mendoza.
Water Resources Bulletin, Vol. 19, No. 4, p 571-576, August, 1983. 6 Fig, 13 Ref.

Descriptors: *Scour, *Culverts, *Mound formation, Bed erosion, Sediment transport, Tailwater, Jets, Sediment deposition.

Culvert installations along transportation routes often alter natural drainage flow conditions. Local scour results when the channelized flow impacts the bed material. One component of the local scour process near a culvert outlet is the formation of an aggraded mound downstream of the scour area. A

series of experiments was performed in which a horizontally cantilevered pipe discharged water onto a bed of sand material. The impacted jet transported material away from the jet, subsequently depositing material downstream of the scour hole. The maximum dimensions of the mound were correlated to the discharge intensity, Qg(-0.5)D(-2.5), the maximum dimensions of the scour hole, time, and tailwater evaluation. The greater the tail water elevation, the higher the mound. The area of influence could be expressed in terms of the length of scour, length of mound, and width of mound or as a function of the hydraulic parameters. (Moore-IVI)
W84-01941

REALISTIC ASSESSMENT OF MAXIMUM FLOOD POTENTIALS,
For primary bibliographic entry see Field 2E.
W84-01962

FLOW DEPTH IN SAND-BED CHANNELS,
Tetra Tech, Inc., Pasadena, CA.
W. R. Brownlie.
Journal of Hydraulic Engineering, Vol. 109, No. 7, p 959-990, July, 1983. 17 Fig, 3 Tab, 46 Ref. NSF grant CME79-20311.

Descriptors: *Friction, *Flow depth, *Channels, Flow discharge, Slope, Water depth, Mathematical models, Statistical analysis, Dimensional analysis, Channel hydraulics, Bed load, Dunes, Ripples, Antidunes.

Six methods of predicting friction factor are evaluated and a new method is presented which better predicts flow depth (and therefore friction factor) when discharge and slope values are known. The goal of the investigation is to define a relationship between depth, discharge, and slope that can be used in a wide range of situations where uniform flow conditions are present and which can also be adapted for numerical modeling applications. None of the six methods completely satisfy the writer's criteria; therefore a new relationship is presented. The proposed technique is based on dimensional analysis, a statistical analysis of a large body of laboratory and field data, and basic principles of hydraulics. Separate equations are developed for the lower (dune and ripple) and upper (flat bed and antidune) flow regimes. The technique also includes a simple method for flow regime determination. Finally, the proposed method is verified through comparison with data sets not used in the derivation of the technique. (Author's abstract)
W84-01963

MAIN FLOW VELOCITY IN SHORT RIVER BENDS,
Technische Hogeschool, Delft (Netherlands). Dept. of Civil Engineering.
H. J. de Vriend, and H. J. Geldof.
Journal of Hydraulic Engineering, Vol. 109, No. 7, p 991-1011, July, 1983. 10 Fig, 1 Tab, 29 Ref.

Descriptors: *Flow velocity, *River bends, Mathematical models, Flow convection, River beds, Pressure gradients, Netherlands, River Dommel.

Results of a mathematical model for the depth-averaged main flow velocity in shallow river bends are compared with measurements in two consecutive sharply-curved short bends in the river Dommel, The Netherlands. The computed main velocity distribution agrees rather well with the measured one in the larger part of each bend. Near the bend, deviations occur which indicate the secondary flow convection should be included in the mathematical model. The inward skewing tendency of the velocity distribution near the entrance of a bend is due to main flow inertia combined with the longitudinal pressure gradients arising from the growth of the transverse surface slope. In the river section under consideration, the gradual outward shift of the main velocity maximum further downstream in the bend is a matter of retarded adaptation of the flow to the bed configuration, rather than of secondary flow convection. Secondary flow convection is only important in the last part of each of the surveyed bends; there it seems to hamper the outward skewing of the flow instead of enhancing it. As the flow stage becomes higher, the main velocity maximum tends to shift towards the inner bank; this must be attributed to the reduced asymmetry of the channel rather than to the slower development of the secondary flow. (Moore-IVI)
W84-01964

FLOOD PLAIN AND MAIN CHANNEL FLOW INTERACTION,
Birmingham Univ. (England). Dept. of Civil Engineering.
D. W. Knight, and J. D. Demetriou.
Journal of Hydraulic Engineering, Vol. 109, No. 8, p 1073-1092, August, 1983. 19 Fig, 2 Tab, 14 Ref.

Descriptors: *Flood plains, *Channel flow, Shear stress, Shear force, Model studies, Hydrologic models, Channel roughness.

Experimental results are presented concerning the discharge characteristics, the boundary shear stress and boundary shear force distributions in a compound section comprising of one rectangular main channel and two symmetrically disposed flood plains. The experiments were conducted in a 15 m flume, 610 mm wide. Two flood plains, 76 mm high and 229 mm wide were added, creating a symmetrical cross section with a center channel 152 mm wide and 76 mm deep. The apparent shear force acting on the vertical interface between one flood plain and the main channel is strongly depth dependent. The apparent shear forces are always positive, indicating that the flood plain retards the main channel flow. Equations are presented giving the proportion of the total flow which occurs in the various sub areas. The division of flow based on linear proportion of the areas is inadequate on account of the interaction between the flood plain and main channel flows. The experimental results apply only to the case in which the flood plains have the same roughness as the main channel and are symmetrically disposed. (Moore-IVI)
W84-01966

MODELLING OF DISCONTINUITIES THROUGH DIPOLE DISTRIBUTION,
Thessaloniki Univ., Salonika (Greece). Lab. of Hydraulics and Hydraulic Works.
E. Sidiropoulos, C. Tzimopoulos, and P. Tolikas.
Applied Mathematical Modelling, Vol. 7, No. 5, p 306-310, October, 1983. 6 Fig, 10 Ref.

Descriptors: *Dipole distribution, *Dams, *Sheetpiles, *Discontinuities, *Flow, Mathematical models, Boundary element methods, Singularities.

The problem of the flow under a dam with a sheetpile in its foundation is treated as a characteristic example of the introduction of dipoles in order to model the discontinuity in the potential function across the cut-off wall. Dipole singularities were used in order to account for the presence of a sheet-pile in the flow. The method is not restricted to a single pile. The same procedure can be applied to the case of more sheet-piles and of arbitrary inclination. The width of the sheet-piles is taken to be zero and the dipoles are placed along the axis of the sheet-piles. A linear boundary element was placed at the tip of the sheet-pile. The coefficients of the linear system of equations are all given in analytical form and no partition into zones is necessary. Very good agreement with analytical results is demonstrated, the mean absolute relative deviation being of the order of 4%. With the insertion of a linear element at the tip of the sheet-pile it was possible to obtain the same value of the potential on both faces of the sheet-pile at that point. (Moore-IVI)
W84-01997

TURBULENCE STRUCTURE OF DILUTE DRAG-REDUCING POLYMER SOLUTIONS IN A RECTANGULAR OPEN CHANNEL FLOW,
Yamaguchi Univ. (Japan). Dept. of Chemical Engineering.
H. Usui, and Y. Sano.
AIChE Journal, Vol. 29, No. 4, p 611-617, July, 1983. 11 Fig, 20 Ref.

Descriptors: *Drag, *Open channels, *Polymers, *Turbulent flow, Velocity, Drag reduction, Bursting, Discharge capacity, Eddies.

The drag reduction phenomenon in a rectangular open channel flow was examined by measuring the longitudinal velocity by means of a laser Doppler anemometer. Drag reduction was detected using 50 and 100 ppm polymer additives (polyethylene oxide). Statistical analysis of the fluctuating velocity showed that the most significant effect of the polymer additive on the large-scale turbulent motion appeared in the turbulent core of an open channel flow. The scale of bursting phenomenon was enlarged by the polymer additive, and the typical ejection process was detected as the remarkable negative fluctuating velocity throughout the buffer and turbulent core regions except near the free surface. The maximum increase of discharge capacity was 40% of the Newtonian fluid case. The skewness factor of polymer solutions showed anomalously high negative value at $y(+) = 70$ to 120. The corresponding flatness factor was much larger than that of water. These observations were interpreted as an increased scale of the large eddy motion in polymer solutions and as the results of suppression of sweep process because of the existence of free surface. (Moore-IVI)
W84-02001

8C. Hydraulic Machinery

DESIGN OF IN-LINE JET INJECTION BLENDERS,
Auburn Univ., AL. Dept. of Civil Engineering.
O. Guven, and L. Benefield.
Journal of the American Water Works Association, Vol. 75, No. 7, p 357-363, July, 1983. 4 Fig, 1 Tab, 26 Ref.

Descriptors: *Mechanical equipment, *Design criteria, Blenders, Injection, Water treatment.

Available information on the initial mixing characteristics of turbulent jets in crossing pipe flow is reviewed, and criteria is given for the optimum design of in-line jet injection blenders. A previously proposed design procedure for centrally injected jets is discussed, and an analysis is presented to indicate how this procedure can be improved. Both the velocity ratio and the diameter ratio should be considered as design variables in the design of in-line jet injection blenders. Optimum conditions for small diameter ratios are characterized by a constant value for the momentum ratio, whereas the optimum momentum ratio for large diameter ratios is not a constant and depends on the diameter ratio. The central jet injection scheme has several advantages as a rapid mix method compared with the side jet injection scheme, and experimental studies are needed to quantify the optimum conditions for the case of central jets. (Baker-IVI)
W84-01800

PUMPS THAT PLAY TURBINES,
Engineering-Science, Inc., Arcadia, CA.
K. R. James.
Water Engineering and Management, Vol. 130, No. 7, p 32, 34, 36, July, 1983. 2 Fig.

Descriptors: *Pumps, *Turbines, *Hydraulic equipment, Energy, Water distribution.

Engineers are now considering standard centrifugal pumps, operating in reverse as hydroelectric turbines to economically tap hidden potential sources of revenue in water distribution systems. Several alternatives can be considered to take full advantage of the economic benefits which can be realized in using reverse pump turbines. Select only those reverse-pumps which have the broadest possible operating range at reasonably high efficiencies. Use multiple turbines to operate singly or in various combinations to match the expected variations in flow and head. Switch turbines at various stages in the life of the hydro station to correspond with changing flow and head conditions. Install reverse pumps which, by changing impellers, can be converted in the future to operate

at different conditions of flow and head. Use a generator which can operate at two different shaft speeds. (Baker-IVI)
W84-01914

8D. Soil Mechanics

GEOPHYSICAL METHOD OF EVALUATING EXISTING EARTH EMBANKMENTS,
Davenport/Hadley Ltd., Golden, CO.
L. M. Hadley.
Bulletin of the Association of Engineering Geologists, Vol. 20, No. 3, p 289-295, August, 1983. 10 Fig.

Descriptors: *Earth dams, *Seismic properties, *Measuring instruments, Soil mechanics, Dam failure, Dams, Safety, Seismographs.

Earth embankments need periodic inspection and monitoring, especially, if settlement or damage is suspected. Currently, earth embankment condition is evaluated through visual inspection and analysis of data from instrumentation such as piezometers and inclinometers. A program to evaluate the condition of existing earth embankments using geophysical methods was developed and is currently being used as part of a safety evaluation of existing earth embankments in the western United States. The geophysical method utilizes the 'common offset' seismic refraction technique which emphasizes areas of change. Seismic lines are run along the dam axis and toe. Anomalous areas, if any, are targeted for drilling. This technique was applied to about 15 dams. A base line data file will be established for all the major earth dams in the United States. New seismic lines could then be run after a dam has undergone an event such as an earthquake and the two sets of data compared. More detailed information will be gained from the seismic data as the program continues and drilling data become available for direct comparison. If a correlation is found between seismic characteristics and physical properties, the amount of drilling required in future studies of settlement at earth embankments should be greatly reduced. (Baker-IVI)
W84-01814

RECONNAISSANCE ESTIMATES OF SUBSIDENCE ALONG SALT-GILA AQUEDUCT, ARIZONA,
Water and Power Resources Service, Sacramento, CA. Mid-Pacific Region.
N. P. Prokopovich.
Bulletin of the Association of Engineering Geologists, Vol. 20, No. 3, p 297-315, August, 1983. 16 Fig, 1 Tab, 32 Ref.

Descriptors: *Subsidence, *Aqueducts, Design criteria, Canals, Construction, Groundwater depletion, Arizona, Salt-Gila Aqueduct.

A new approach was recently tested for prediction of subsidence along the Salt-Gila Aqueduct. This concrete-lined aqueduct is 104 km long and follows basin margins eastward of Phoenix, Arizona. Prominent subsidence started with an intensification of ground-water pumpage in the 1940's. Available annual leveling data along the alinement extend from 1971-1978. It was assumed that the 1971-76 subsidence amounted to 20% of past subsidence occurring during overdraft of ground water. Experience with other studies indicated that future residual subsidence along the aqueduct caused by pre-1976 overdraft could be equal to the amounts of past subsidence. Estimated declines of ground water between 1976 and 2005 and between 1976 and 2020 were calculated to be respectively 16% and 22% of the 1923-76 decline in the northern portion and 65% and 112% in the southern portion of the alinement. These ratios were used for estimates of post-1976 subsidence caused by pre-2005 and pre-2020 overdrafts (assuming constant ratios between subsidence and overdraft). Maximum estimated subsidence was 1.91 m for 2005 and 2.09 m for 2020. However, this subsidence will not be achieved for many years after 2005 and 2020. The amount of actual 1976-2005 and 1976-2020 subsidence was estimated using an assumed 30-year half-life of residual subsidence. The values were up to 0.96 m for the year 2005 and up to 1.30 m for the year 2020. These rough estimates were made at a cost of less than $10,000 and verified the sophisticated costly preconstruction estimate. A similar comparison of 2-3 independent estimates appears to be a sound approach for all large projects. (Author's abstract).
W84-01815

INEXPENSIVE TECHNIQUE TO MEASURE SUBSIDENCE ALONG CANALS,
Water and Power Resources Service, Sacramento, CA. Mid-Pacific Region.
N. P. Prokovich, and H. J. Hall.
Bulletin of the Association of Engineering Geologist, Vol. 20, No. 3, p 317-323, August, 1983. 7 Fig, 110 Ref.

Descriptors: *Canals, *Subsidence, *Irrigation canals, Soil mechanics, Water depth, Delta-Mendota Canal, Friant-Kern Canal, California.

Irrigation canals, particularly in dry areas, are frequently affected by land subsidence. Monitoring of such subsidence is essential for operation, maintenance and possible rehabilitation of canals. Periodic leveling of canal alignments is expensive, time consuming, and locally may be obscured by tectonic movements. An inexpensive and rapid method for the measurement of subsidence by determining the depth of water in canals, as applied in the Mid-Pacific Region, is described below. Large canals are divided into pools by check structures which are designed to control or to stop water flow by the manipulation of check gates. For subsidence studies, depth of water in a canal is measured at the upstream and downstream ends of all pools during standstill time with check gates completely closed. Actual depth of water may be different in different pools, but the difference of depth at downstream and upstream ends of each pool corresponds to the invert gradient of a pool and is constant in stable areas. The difference changes, however, in pools affected by subsidence. These changes reflect the amount of subsidence during the time interval between consecutive sets of measurements. In particularly long pools additional depth measurements can be made at convenient strucure sites, such as bridges. This method was used for rough measurements of subsidence in the Delta-Mendota and Friant-Kern Canals in California. (Author's abstract)
W84-01816

MEASURING THE CONTRIBUTION OF LAND AND WATER TO AGRICULTURE,
Idaho Univ., Moscow. Dept. of Agricultural Economics.
R. B. Long.
Water Resources Bulletin, Vol. 19, No. 4, p 613-617, August, 1983. 6 Tab, 3 Ref.

Descriptors: *Irrigation effects, *Agriculture, *Dry farming, Idaho, Wheat, Barley, Hay, Regression analysis, Income.

A paucity of yield data does not allow direct measurement of the contribution from irrigated crop agriculture, nor does it allow evaluation of the contributions from livestock which are dependent upon irrigated feed. In order to isolate the dryland and irrigated contributions for wheat, barley, and hay, county data for southern Idaho (34 counties) were assembled for irrigated acres, dryland acres, and total production. Regression analysis was performed with total output a function of dryland acres and irrigated acres. Regression results indicate that 80% of Idaho farm income is associated with irrigation, and that 75% of the farm income in the 17 western states is associated with irrigation. For the United States as a whole, 13.7% of the total cropland (irrigated land) produced 41.3% of all cash receipts from farming in 1978. If 14% of the land can produce 40% of the value of production, perhaps 35% of our land can produce all our food and fiber needs. Such an allegation has several implications in terms of the adequacy of our land and water resources. Irrigated agriculture is far more important on the basis of dollars of output than one might expect by simply observing and comparing dryland and irrigated acreage data. The role of technology has not been exhausted, especially if current dryland areas could be made to produce like those that are already irrigated. (Moore-IVI)
W84-01947

EROSION IN RELATION TO FILTER DESIGN CRITERIA IN EARTH DAMS,
California Univ., Davis.
K. Arulanandan, and E. B. Perry.
Journal of Geotechnical Engineering, Vol. 109, No. 5, p 682-698, May, 1983. 11 Fig, 3 Tab, 42 Ref.

Descriptors: *Rockfill dams, *Earth dams, *Erosion, *Critical shear stress, Dam stability, Piping failure, Dam failure, Dam filters, Clay, Dam core, Design criteria.

The current design practice for filters in earth and rock fill dams permits the use of widely graded sand-gravel mixtures as filter materials. The use of these criteria without consideration of the erodibility characteristics of the core material and crack potential of the filter has caused near failure and total failure of several dams. A new method is presented for quantifying the erodibility of soils based on the use of critical shear stress, Tc, developed due to hydraulic flow in the cracked zone of a dam. Critical shear is influenced by the clay type and amount, composition of pore and eroding fluid, and structure of the soil. The use of Atterberg Limits to classify erosion characteristics is inadequate. A direct correlation between the critical shear stress required to cause erosion and the piping failure of several dams was found. Core fines with Tc values less than 4 dynes/sq cm are one of the contributing factors causing piping failure of dams. Even if the clay is erodible, it is possible to prevent dam failure is adequate protective filters are provided. Correctly quantifying erodibility and carrying out filtration tests using the eroded fines and proposed filter material is recommended for the safe design of protective filters. The degree of clogging of the pores in the filter material may be used to evaluate its cracking susceptibility. (Moore-IVI)
W84-01958

STRESS AND SEEPAGE ANALYSIS OF EARTH DAMS,
Schnabel Engineering Associates, Bethesda, MD.
G. C. Li, and C. S. Desai.
Journal of Geotechnical Engineering, Vol. 109, No. 7, p 946-960, July, 1983. 14 Fig, 3 Tab, 21 Ref.

Descriptors: *Earth dams, *Stress analysis, *Seepage, *Dam stability, *Earthworks, Soil mechanics, Mathematical models, Embankments, Soil saturation, Dam construction.

A finite element procedure is developed for stress, seepage and stability analysis of dams and earthbanks. The soil behavior is modeled by using linear elastic, nonlinear elastic and plasticity based laws. The seepage analysis is based on a residual flow scheme involving saturated and unsaturated zones in which the original mesh remains invariant during the transient flow and iterations. By using the same mesh for stress analysis including sequential embankment construction, it is possible to superimpose directly the effects of external and seepage forces. If appropriate pressure-permeability relations are available, it is possible to incorporate effects of partial saturation during construction. It is also possible to include in the analysis changes in the dam geometry during the deformation process. The procedure has been found to provide satisfactory correlation with analytical solutions and field observations for a number of problems. It can be useful and appropriate for nonlinear stress, seepage and stability analysis of dams and earth banks. (Moore-IVI)
W84-01959

UNSTEADY SEEPAGE ANALYSIS OF WALLACE DAM,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
M. M. Aral, and M. L. Maslia.

Journal of Hydraulic Engineering, Vol. 109, No. 6, p 809-826, June, 1983. 12 Fig, 1 Tab, 27 Ref.

Descriptors: *Embankments, *Earthworks, *Seepage, Mathematical models, Unsaturated flow, Saturated flow, Dam piping, Dam filters, Drainage, Pore pressure, Finite element analysis, Pumped storage, Georgia, Oconee River, Wallace Dam.

The Wallace Dam is a pumped storage hydroelectric project on the Oconee River near Eatonton, Georgia. The main body of the Wallace Dam consists of a concrete gravity non-overflow section, a gated spillway section, and east and west earthfill embankment sections. Transient seepage patterns in the west dike station 58+00 of Wallace Dam were studied through a saturated-unsaturated seepage analysis using a finite element solution technique. Numerical results obtained from the model using Design Data III soil types compare favorably with the recorded field observations. The internal drainage structure is efficient in reducing pore pressures in downstream sections of the earth dam. Considerable care should be given to the design of the inner filter zone to avoid internal piping or blockage, or both, of the filter structure due to piping. The numerical results predict higher permeabilities in the clay fill zone with a higher quantity of seepage. Suitability of the finite element analysis is once again demonstrated in analyzing transient behavior of an earth dam using saturated-unsaturated flow analysis. (Moore-IVI)
W84-01960

8F. Concrete

MANUFACTURE AND USE OF ASBESTOS CEMENT PIPES,
S. C. Taunton.
Chemistry and Industry, No. 17, p 667-670, 5 September, 1983. 5 Fig, 2 Tab.

Descriptors: *Pipes, *Asbestos cement, Cement, Asbestos, Drinking water, Public health, Coatings, Corrosion.

Asbestos cement (AC) ranks as one of the major pipe materials in service today. Estimates suggest that 15 to 20% of all water distribution mains in the United Kingdom are made of AC. The high density compaction of the cement, reinforced by the asbestos fiber, gives the pipe material its high strength characteristics and its inherent resistance to aggressive attack. Particular features of the manufacturing process ensure that the asbestos fibers are oriented such that mechanical strength in both the axial and circumferential plane is developed; each lamination is consolidated in turn, as buildup proceeds, by a hydraulically loaded roller beam; the resulting material is homogeneous, tough and easily machineable; and the mandrel confers a smooth finish to the pipe bore. Asbestos fiber is effectively inert to all substances commonly found in ground water, potable water and sewage. The high density compaction of the cement in the pipe also provides good resistance to aggressive attacks. Animal studies on the effects of possibly ingested asbestos have indicated no increased risk arising from fiber ingestion. Epidemiological studies show no substantive evidence of risk. (Baker-IVI)
W84-02019

POLYETHYLENE PIPING SYSTEMS FOR USE IN THE WATER INDUSTRY,
Stewarts and Lloyds Plastics, Huntingdon (England).
J. A. Denning.
Chemistry and Industry, No. 17, p 671-673, 5 September, 1983. 3 Fig, 1 Tab.

Descriptors: *Pipes, *Polyethlyene, Pipelines, Water distribution, Corrosion.

Polyethylene piping systems now being introduced to the water industry are modelled on the system used since about 1969 for the distribution of natural gas. The water system will differ in operating pressure and in the pigmentation of the polymer, but it will use the same high performance medium density polyethylene as supplied to meet gas specifications. Polyethylene piping systems do not need internal or external protection against corrosion and no environment effects should be observed on the system during its life. However, piping installed in ground contaminated with organic solvents or fuel oil can result in the water being contaminated by these pollutants diffusing through the pipe wall. (Baker-IVI)
W84-02020

8G. Materials

RECENT DEVELOPMENTS IN MATERIALS USED IN THE WATER SUPPLY INDUSTRY,
R. F. Stokes.
Chemistry and Industry, No. 17, p 659-663, 5 September, 1983. 7 Fig, 8 Ref.

Descriptors: *Pipes, *Water distribution, Water supply, Pipelines, Asbestos, Cement, Iron, Plastics.

Most pipes used in the drinking water systems are grey iron, either vertically cast or centrifugally spun cast, and consequently brittle. Iron pipes seldom fail in service due to strength limitations alone. Corrosion is more usually the cause and a reduction in wall thickness might be expected to exacerbate this problem. The typical method of protecting pipes from external corrosion has been to use a bitumen dip or coal tar. Currently recommended methods include the use of polyethylene sleeving as this has been shown to provide long term benefit at a relatively low cost. Zinc spray coating applied to the iron pipe before bitumen application has also been effective. Asbestos cement pipes have been used successfully for many years as pressure pipes. They are reasonably cheap and relatively trouble free in hard water areas. Plastic pipes came into use in 1955, but not until the 1960s with the use of uPVC, did their presence become significant. (Baker-IVI)
W84-02017

DEVELOPMENT OF PROTECTION SYSTEMS FOR BURIED DUCTILE IRON PIPES,
Stanton and Staveley Ltd., Nottingham (England).
H. H. Collins.
Chemistry and Industry, No. 17, p 663-666, 5 September, 1983. 1 Fig, 4 Tab, 9 Ref.

Descriptors: *Pipes, *Corrosion, Zinc, Plastic, Coatings, Tar, Ductile iron pipes, Pipelines, Water distribution, Sewer systems, United Kingdom.

The behavior of grey cast iron, when buried in a wide variety of soils, has been extensively explored by the National Bureau of Standards. Such pipe is by far the most common type used at present in Britain's cities and countryside for the transport of water, sewage, or gas. In general, the wettest soils with the lowest electrical resistivities are the most aggressive; the rate of corrosion penetration into iron tends to decrease with time; iron surfaces are attacked non-uniformly, leading to irregular pitting rather than uniform thinning; and corrosion results are extremely variable, even for identical materials buried in the same soil. For many years the standard protection to cast iron pipes has been a 70-100 micrometer coating of coal tar, applied by dipping the pipe into a bath of molten tar. Additional protection is needed by all iron pipes likely to be exposed in corrosive soils. The most convenient and economic system and widely used in the United Kingdom is encasing the pipe in a sleeve of polyethylene film 200 micrometers thick. A thin coating of metallic zinc with a top coating of coal tar or bitumen paint can be used to protect spun iron pipes. (Baker-IVI)
W84-02018

FACTORS INFLUENCING THE CHOICE OF MATERIALS FOR EPOXY RESIN RENOVATION OF WATER MAINS,
WRC Engineering, Swindon (England).
I. C. Warren.
Chemistry and Industry, No. 17, p 673-678, 5 September, 1983. 5 Fig, 5 Tab, 13 Ref.

Descriptors: *Pipes, *Water distribution, *Epoxy resins, Resins, Water mains, Microorganisms, United Kingdom.

The overall condition of the water distribution network is of concern in the water industry of the United Kingdom. Accelerated durability testing of epoxy resin linings has shown that a life of at least 20 years can be realized. No mechanism for deterioration has been observed and service lives in excess of this figure are expected. Epoxy resin linings which have been in service for up to four years are showing no signs of deterioration. Increases in microbiological activity following renovation of water mains with epoxy resin materials have frequently been noted. This activity is generally restricted to nonpathogenic microorganisms capable of growing at 22 degrees C on yeast extract agar. Epoxy resins containing benzyl alcohol can support the growth of microorganisms within the limits of the test procedure. The use of resins free of benzyl alcohol has not completely eradicated the incidence of microbial activity but it has reduced the duration of the problem. (Baker-IVI)
W84-02021

EVALUATION AND DEVELOPMENT OF TECHNICAL THERMOPLASTIC SYSTEMS FOR DESALINATION AND OTHER WATER TREATMENT APPLICATIONS,
General Electric Plastics B.V., Bergen op Zoom (Netherlands).
For primary bibliographic entry see Field 3A.
W84-02031

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